Materials & Methods

Selection & use of

metals, nonmetallics, parts, finishes,

in product design & manufacture

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Electroplated Coatings—M & M Manual No. 128

Making Parts from Steel Tubing

Polyamide-Epoxy Plastics for Tooling

Soldering Difficult Materials

Titanium Parts by Powder Metallurgy

Anodized Coatings for Aluminum

Synthetic Resins Solve Design Problems

Complete Contents—page 1

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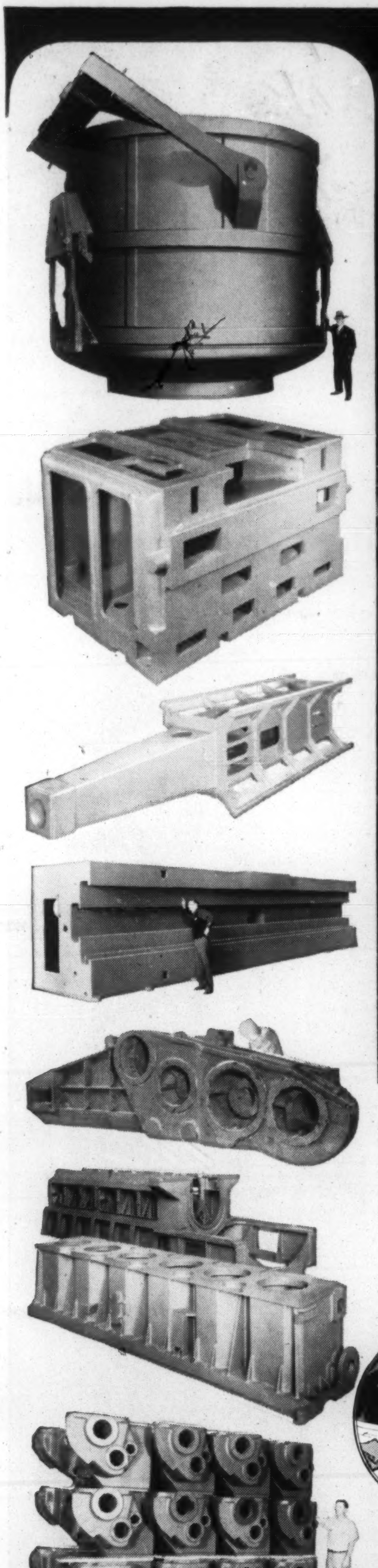
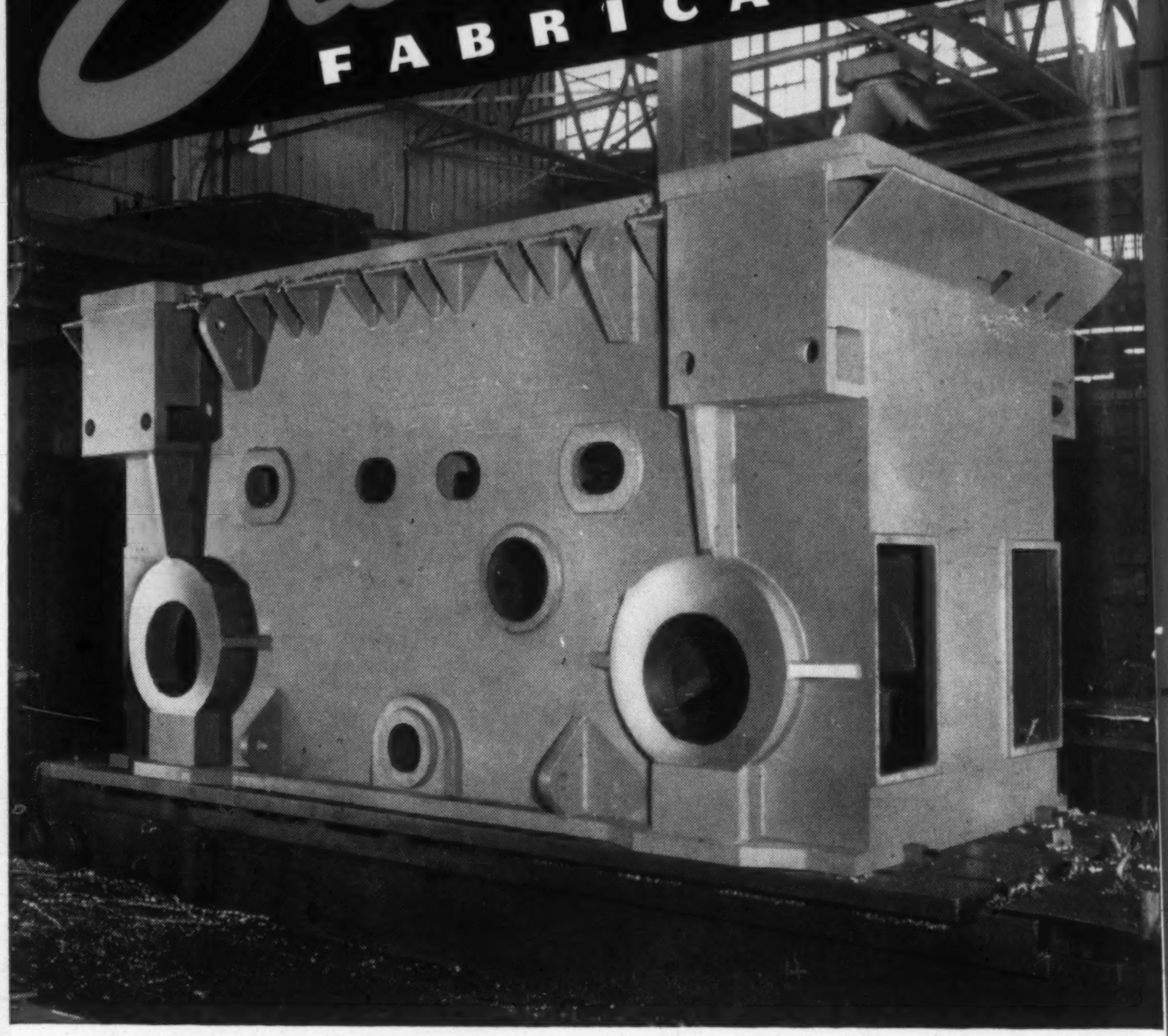


Steel-Weld
FABRICATION



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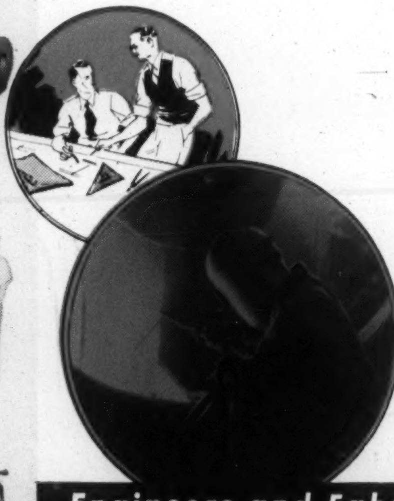

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Published monthly by
REINHOLD PUBLISHING CORP.
430 Park Avenue
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Materials & Methods is indexed regularly in the Engineering Index and the Industrial Arts Index

Materials & Methods®

Selection & use of

metals, nonmetallics, parts, finishes

in product design & manufacture

JULY 1956 **VOL. 44, NO. 1**

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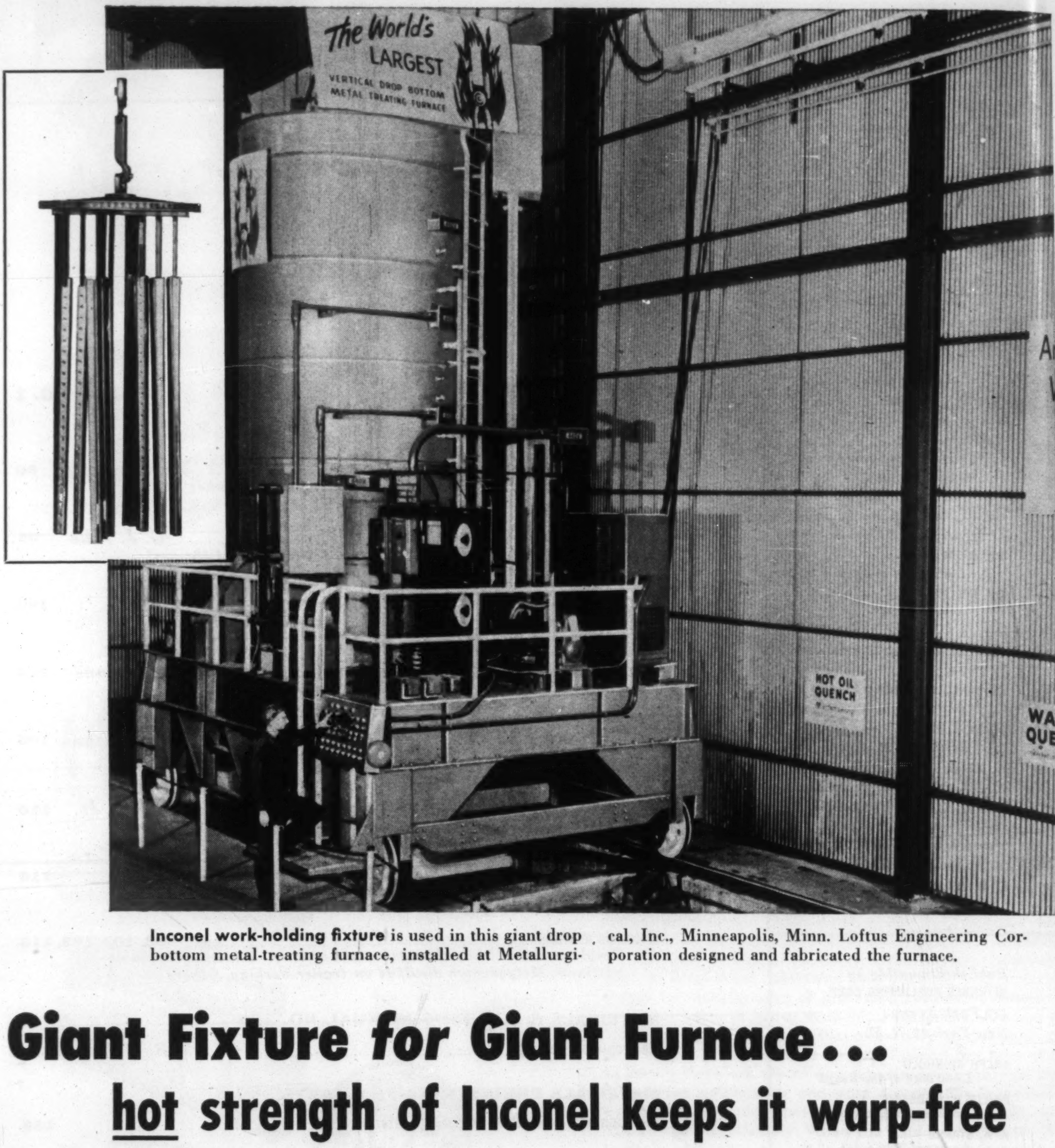

Inconel work-holding fixture is used in this giant drop bottom metal-treating furnace, installed at Metallurgical, Inc., Minneapolis, Minn. Loftus Engineering Corporation designed and fabricated the furnace.

Giant Fixture *for* Giant Furnace...

hot strength of Inconel keeps it warp-free

Look at this Inconel* nickel-chromium alloy workholder (inset).

It's more than seven feet in diameter. Suspends extra long, extra heavy, steel and aluminum parts vertically during heat-treatment. And also during the quench in oil, water, or hot salt.

The furnace hardens, anneals, stress relieves, and normalizes. In controlled endothermic or neutralene atmospheres. At temperatures up to 2200°F. Despite all this, the Inconel alloy fixture has resisted corrosive attack, cracking, and warping more than a year. In fact, it looks almost new.

That's because Inconel alloy has unusual "hot" strength, withstands thermal shock, and maintains resistance to oxidation up to 2100°F. It also resists carburization and many other forms of attack by heat-treating atmospheres.

What's more, Inconel alloy is readily fabricated, easy to weld. Specify Inconel next time you need a fixture to withstand severe conditions.

*Registered Trademark

Equipment pictures available — Complete data on the use of Inconel at high temperatures is covered in picture-packed Inco booklet, "Keep Operating Costs Down When Temperatures Go Up." Write for a copy, today.

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Materials Outlook

TITANIUM ALLOY SUPPLIERS are "still on the learning curve" according to manufacturers attending a recent titanium symposium. Some specific conclusions: 1) Bend strength and formability of titanium varies from sheet to sheet. Suppliers are still working on rolling high strength alloy sheets that will vary less than 5 to 8% from true flatness. 2) Technical standards for analysis of titanium and its alloys have not been sufficiently established. 3) Supplies of special shapes and types of titanium cannot be obtained as rapidly as needed.

GALLIUM has been used as a sealant in glass joints and valves in laboratory vacuum equipment. Effective operating time of tapered ground glass joints was more than doubled by metallic gallium sealant.

POLYETHYLENE-PAPER LAMINATES have been improved by using titanium ester adhesion promoter. Use of this type of adhesion promoter permits lowering extrusion temperature, thereby eliminating the acetylene-like odor of oxidized polyethylene. Physical strength of both paper and plastic are retained, and if both sides of the paper are treated, overlap heat seals of plastic to paper are possible.

DISPERSING INORGANIC MATERIALS in molten metals promises to give rise to a host of new properties. Wide range of materials that can be dispersed includes emery, sand, calcined alumina, granite, graphite and diamond, cast iron, hard steels, glass, mica, asbestos, and the carbides of silicon, boron and tungsten. Metals in which these materials can be dispersed include aluminum, zinc and copper.

HEATLESS WELDING OF METALS by ultrasonics produces welds with the same strength as those made by ordinary high pressure and resistance spot welding. Ultrasonic waves cause the molecules in the base metals to vibrate rapidly and to merge, fusing the metals.

FLUID LUBRICANTS that will operate between 1000 and 2000 F are in sight. Metals can function up to 2000 F in aircraft use, but the upper limit for present day fluid lubricants is about 500 F in hydraulic systems and 350 F in bearings. Silicone fluids can take up to 600 or 700 F.

ANODIZED ALUMINUM, according to a British report, offers no corrosion prevention advantage in industrial environments unless regular maintenance is possible. The report concludes that anodizing is not to be recommended for severe conditions, such as exposure in an industrially polluted coastal atmosphere.

Materials Outlook

PRICE TRENDS in certain materials continues downward. Copper is dropping in price. At press time, custom smelters were offering electrolytic copper at 40¢ per lb delivered. Brass strip, sheet and scrap, reflecting the copper drop, were reduced by Olin Mathieson's Metals Div. from 1 to 1½¢ per lb. Titanium was reduced 20¢ per lb by Titanium Metals, bringing the price to $3.25. Powdered nylon is being offered by National Polymer Products at a 40% reduction in price. Fluorocarbon rubbers were reduced more than 30% by M. W. Kellogg.

CERIUM METAL is now available for experimental work. The metal, of 95% purity, comes in 1-lb piglets priced at $15 per lb.

TRANSPARENT CONDUCTIVE COATINGS can withstand high power densities without failure. In recent tests, densities of 6 watts per sq in. were sustained continuously for hundreds of hours at operating temperatures over 500 F. (More details next month.)

NEW DEVELOPMENTS IN PAINT: 1) a new type of paint utilizing dextran, a sugar derivative, is said to be noninflammable and quick-drying. Paint is a blend of organic solvent-soluble benzyl dextrans which are nonhydroscopic and water repellent. 2) Experiments indicate that alkyd resins derived from isophthalic acid excel phthalic anhydride alkyds in surface coating applications. The isophthalic alkyd resins have high gloss retention and good thermal stability. 3) Detectability experiments conducted by the Navy show that orange and scarlet fluorescent paints can be seen from the greatest distances.

SEAMLESS HOLLOW SHAPES can be produced from single sheets of rubber or thermoplastic resins. Technique consists of thermochemically splitting the sheet in a plane parallel to the sheet faces and inflating the split area. Process eliminates cementing or welding of seams and allows production of complex designs. Used in Germany, the process has saved up to 50% in raw material and man hours compared to conventional forming methods.

RAPID INSPECTION OF STEEL up to 10 in. thick is possible with a two-million-volt Van de Graaff x-ray generator recently put into operation. Less than 1 min exposure is required for thicknesses under 5 in. The unit records discontinuities thinner than ½% of total thickness.

BARK FROM THE CALIFORNIA REDWOOD TREE can be refined into a clean fiber and used as filler for plastics, or can be made into felted sheets for separating lead plates in storage batteries. Process is an outgrowth of research to utilize waste material — somewhat more than half of the lumber cut — in redwood lumbering operations.

Materials BRIEFS

Boy-Proof Panes

Windows of plastics are being considered in some schools to thwart rock throwing boys. Plastics panes won't shatter, but those tested have a tendency to cloud and scratch easily.

Vested Interest

Reinforced plastics plates for use as armored vests are being ordered in quantity by the U. S. Marine Corps. Tested in the Korean War, the vests greatly lessened battle wounds.

Little Jewels

Jewel bearings may soon be produced automatically. Previously hand formed, the tiny gems are used to provide bearing surfaces in precision instruments.

Got Everything?

Mechanical pencils of platinum and palladium are in production and will retail for $500 and $250 respectively. More prosaic varieties are available in chromium, silver and Monel.

Lightly Heeled

Strong, lightweight high heels for women's shoes are now being cast in magnesium.

Thin Slices

Quartz crystals for radios are sliced by high frequency waves. Vibrating 25,000 times per sec, the sound cutter can cut slices down to 0.033 in. thick.

Big Tread

Rubber tires, 4 ft wide and 10 ft tall, were fabricated for a cross-country freight vehicle designed for transporting equipment above the Arctic Circle. Aluminum was used in the body construction to cut down weight.

LOW-COST BEARING METALS FOR EVERY LOAD AND SPEED

Copper alloys are traditional for friction bearings. There is at least one suitable for almost every kind of bearing application.

The familiar leaded bearing bronzes are easy to machine, and the soft lead in the hard copper-tin matrix acts as a lubricant under severe conditions. Federated copper-tin alloys have high compression strength. Aluminum bronzes withstand exceptional loads, speeds and temperatures and stand up well in difficult sliding operations.

Babbitts, which are bearing alloys having a tin or lead base, and which are bonded to a steel or bronze shell, offer good frictional properties, excellent running-in properties and good behavior where lubrication is poor or unreliable. Federated research has provided many improved babbitts for modern bearing service.

If your problem is the design of a low-cost friction bearing, Federated may be able to give you valuable suggestions. Our metallurgists work with many kinds of non-ferrous metals, and they know how to alloy them correctly to obtain the specific physical characteristics you require.

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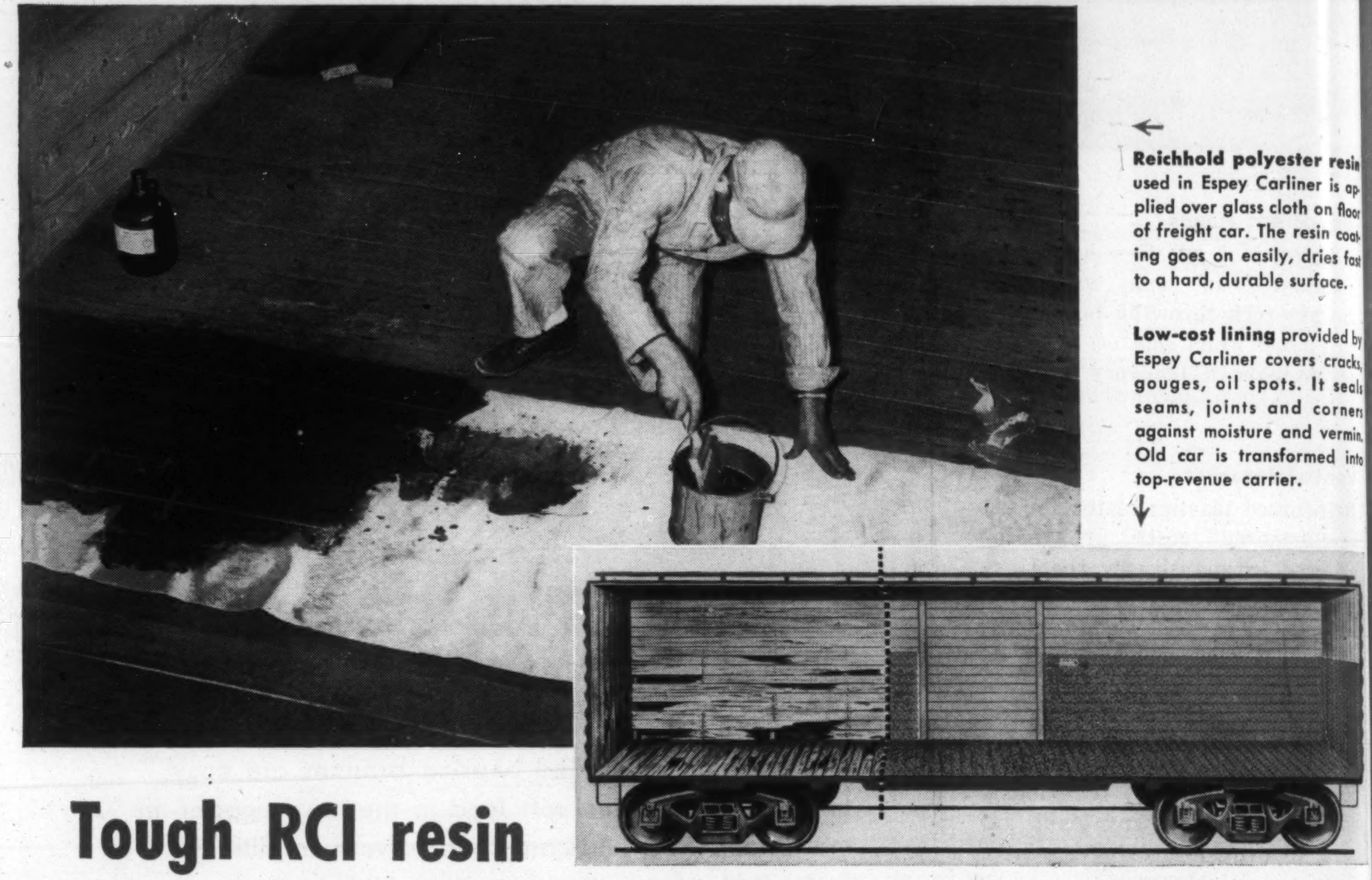
"Beat-up boxcars made like new with Espey Carliner!"



Reichhold polyester resin used in Espey Carliner is applied over glass cloth on floor of freight car. The resin coating goes on easily, dries fast to a hard, durable surface.

Low-cost lining provided by Espey Carliner covers cracks, gouges, oil spots. It seals seams, joints and corners against moisture and vermin. Old car is transformed into top-revenue carrier.

Tough RCI resin coating upgrades old cars in just a few hours!

● The heavy industrial equipment transported by railroads splinters and spoils wooden walls and floors of freight cars. This wear-and-tear progressively downgrades the cars to class C or D — cars unsuitable for commodities like edible grains.

Now, however, the Espey Carliner, developed by Spring Packing Corp. of Chicago with technical help on resin coatings from Reichhold, returns these cars to "class A" status. *In fact, Carliner treatment actually results in car walls and floors that are "better than new!"*

Two coats of special RCI polyester resin, brushed onto glass cloth, do the job quickly and economically. The resulting interior surfaces are *harder, more durable, more easily cleaned, provide better insulation, and are more resistant to moisture and chemicals than the original wooden walls and floors.* The lining is unaffected by freezing, heat, corrosion or shock.

"Reichhold was a great help to us with technical service" says John T. Landreth, president of Spring Packing. "They worked closely with our people, tailored just the right polyester resin formulation for our need. And they make fast deliveries, too!"

Whether *you're* interested in plastic coatings, molded or laminated plastics, RCI Technical Service can find a resin formulation that gives *you* important advantages, too! Write RCI about polyesters for your products. And ask for *booklet A*.

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Synthetic Resins • Chemical Colors • Industrial Adhesives • Plasticizers
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REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N. Y.

For more information, turn to Reader Service Card, Circle No. 487

Men of Materials...

Marcel A. Cordovi, Chief Metallurgist of the Atomic Energy Div. of Babcock & Wilcox Co. also heads the division's Materials & Testing Dept. Mr. Cordovi has served as a Metallurgical Consultant to Brookhaven National Laboratory since 1951 and is Adjunct Professor of Metallurgical Engineering at Polytechnic Institute of Brooklyn. He is chairman of the Industrial Committee on Reactor Materials, Atomic Industrial Forum, Inc., and of the Subcommittee on Nuclear Reactor Materials, ASTM.

Cordovi says:

"Engineering data on radiation damage are vital to nuclear power plant design."

"Reactor design considerations dictate unusual requirements in nuclear properties in addition to the especially stringent demands of mechanical stress, corrosive environment and high temperature. As a result reactor metallurgists have been beset by a host of materials problems, some of which are unique to the nuclear field.

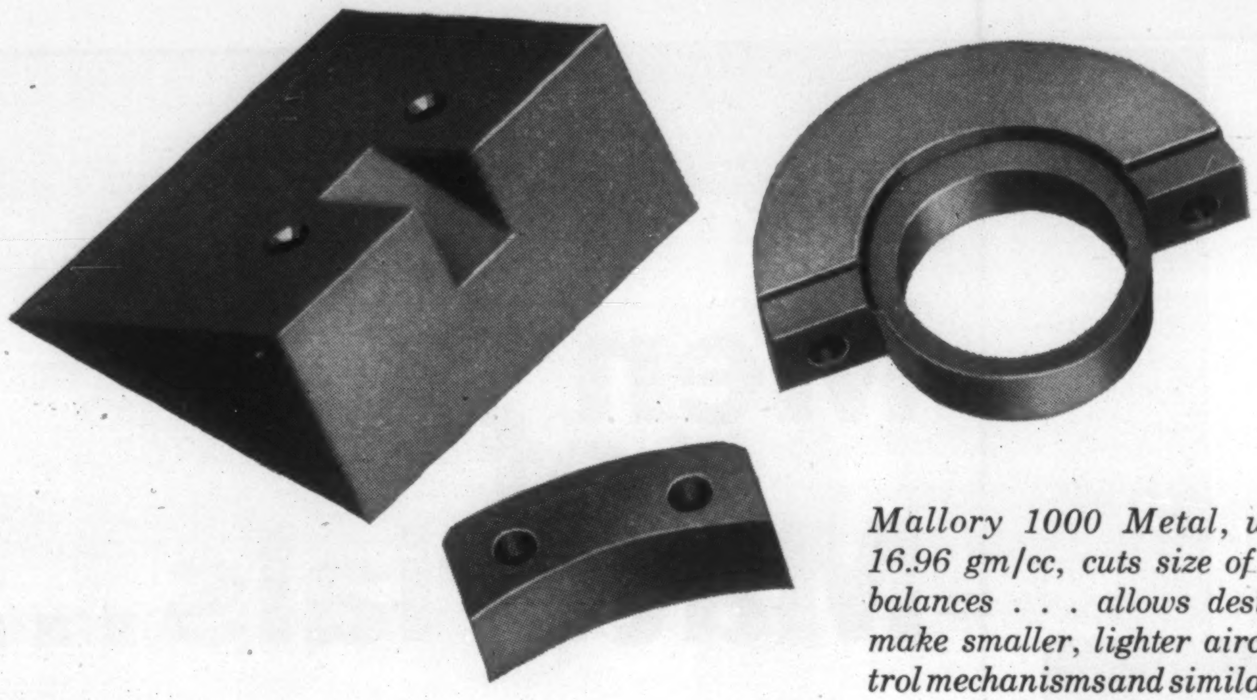
"The most significant of these problems is the radiation damage to materials used in reactor construction. In the case of nuclear fuel materials, this irradiation-induced damage takes the form of embrittlement and gross dimensional changes which can sharply limit the operating life of the composite fuel elements.

"Other components of a reactor are also affected by neutron bombardment but to a much lesser degree than fuel materials. The most significant irradiation effect in materials of construction is the change in the temperature of transition from brittle to ductile fracture.

"Radiation damage tests conducted to date have only contributed to a general metallurgical understanding and qualitative appraisal of irradiation-induced effects in reactor materials. Due to lack of sufficient control or measurement of test variables, the data developed so far cannot be correlated by standard statistical methods of analysis and are therefore not applicable to design on a broad basis.

"As additional reactors utilizing standard engineering test procedures become available, we shall understand more fully the various facets of radiation damage and at the same time augment our knowledge of solid state matter."

P. R. MALLORY & CO. Inc.
MALLORY



Mallory 1000 Metal, weighing 16.96 gm/cc, cuts size of counterbalances . . . allows designers to make smaller, lighter aircraft control mechanisms and similar devices.

How to save weight . . . by using heavier metal

MALLORY 1000 METAL Proves Ideal For—

Compact gyroscope rotors

Mallory 1000, with properties especially developed for this service, gives exceptionally high inertia in small space . . . increases sensitivity of gyros.

Smaller radioactive shields

Up to 40% more efficient than lead, Mallory 1000 proves superior for shielding cyclotron and synchrotron radiation, for hot isotope storage, and for radiation switching from source.

Write for technical bulletins.

You can reduce the size (and thus the weight) of many control assemblies—housings, linkages, other structural elements—by trimming the dimensions of counterbalances, balance weights, and similar "mass components". High density Mallory 1000 makes this practicable. Twice as dense as steel or brass, and far stronger than lead, Mallory 1000 provides designers with the ideal material for compacting many mechanisms.

Designers will appreciate the high uniformity of characteristics which Mallory 1000 offers. Density, tensile strength, modulus of rupture, and elongation are accurate within narrow limits. You can base accurate design calculations on specific, actual figures—instead of guessing with vague "representative" properties. Mallory 1000 leads all other high density metals in adherence to firm specifications. In addition to its high density and strength, the metal offers ready machinability to high surface finish.

Wherever you need concentrated mass or inertia—in balance weights or rotating elements—it will pay you to look into Mallory 1000. Write for complete technical data.

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For information on titanium developments, contact Mallory-Sharon Titanium Corp., Niles, Ohio

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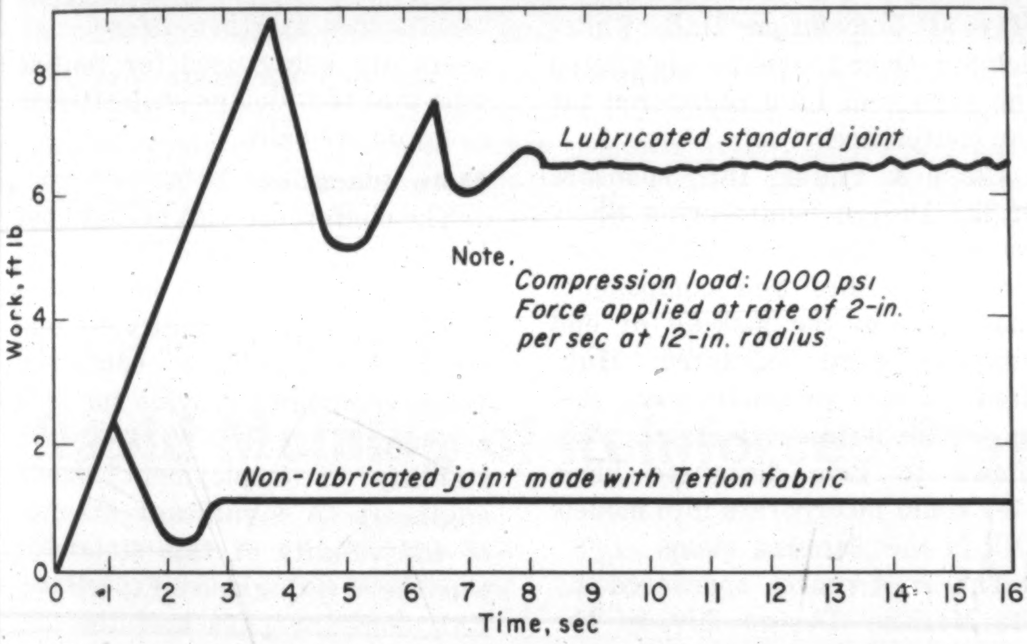
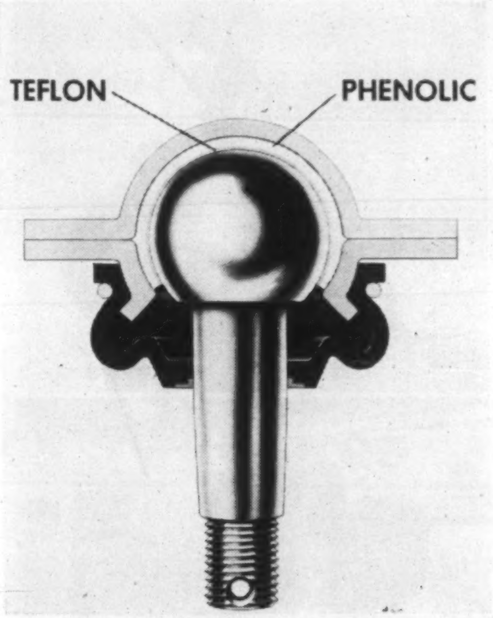
MATERIALS ENGINEERING NEWS

This month

- ▶ *Design show report*
- ▶ *Vinyls improved*
- ▶ *NBS metal conference*



Frictional performance *of ball stud automotive suspension joints.*



Cross section *of suspension ball joint utilizing Teflon.*

Teflon Fabric Used to Face Metal Bearings

Cuts friction, eliminates need for lubrication

■ Use of Teflon fabric to face metal suspension joints may be the way to eliminate the need for conventional lubrication in many types of bearings. Currently used in an automobile suspension joint, Teflon fiber has reduced the amount of friction by more than 50% in comparison with standard lubricated suspension joints.

Developed by American Metal Products Co., of Detroit, in cooperation with Du Pont, the technique represents a new tool for the bearing design engineer. Promising applications include use in parts that are hard to reach for lubrication, parts that are to operate in extreme temperatures, and parts subject to corrosive chemical environments.

A ball-and-socket suspension joint utilizing Teflon fabric is made as follows:

1) Teflon fiber is double woven with a backing of nylon or cotton; 2) this fabric is laminated with cotton-reinforced phenolic resin and formed into a cup which lines the socket; 3) metal parts are coated with a special grease to prevent corrosion; 4) the joint is assembled and the preformed bearing is molded in place, assuring a spherical contact between the ball stud and the bearing; and 5) the joint is sealed.

Preliminary testing indicates that these bearings will last the lifetime of the automobile without lubrication or other maintenance. Tests conducted under a compression load of approximately 1000 psi showed that a force of 9.4 lb was required to move the standard joint and 7 lb to keep it moving after the starting friction was overcome, whereas the force required for the Teflon-lined joint was initially 2.1 lb and dropped to 1.2 lb. The smaller drop from starting to running friction results in less jolt, which means smoother operation.

Company displays *at the Design Engineering Show offered engineers and designers an opportunity to examine new materials and to question company representatives about new design applications.*

Design Show, Conference Highlight Materials Use

■ A success from every angle was the consensus of opinion voiced by engineers and designers attending the First Design Engineering Show and Conference, held in May at Convention Hall, Philadelphia. Over 13,000 people visited the show and 1300 registered for the conference.

Clapp & Poliak, Inc., sponsors of the Design Engineering Show estimated that over 30,000 materials, finishes and components that go into the making of end products were exhibited. Hundreds of new products, some still in the experimental stage, were shown to give designers ideas they could incorporate into models still in the planning stage.

The conference, sponsored by the Machine Design Div. of the American Society of Mechanical Engineers, covered value analysis in product design, how to get and train engineers, materials selection and employee patents and inventions. Standing room only characterized most of the sessions.

Value analysis

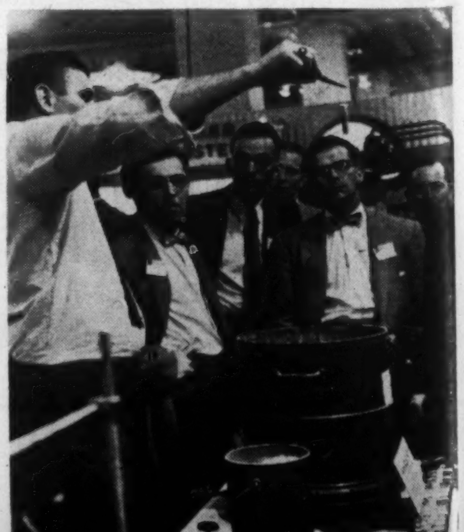
Every man employed as a value analyst by General Electric Co. is saving the company at least 50 times his annual salary each year and some are doing far better than that, according to company engineers reporting to the conference. The value analysis program calls for a single specialist to analyze every factor of cost in a product so that it may be produced at the lowest possible price.

In discussing the place of the designer in industry, one expert remarked that many designers are not being properly utilized and trained. In study after study, results indicate that design engineers are being used for routine jobs that technicians or draftsman could do, he said.

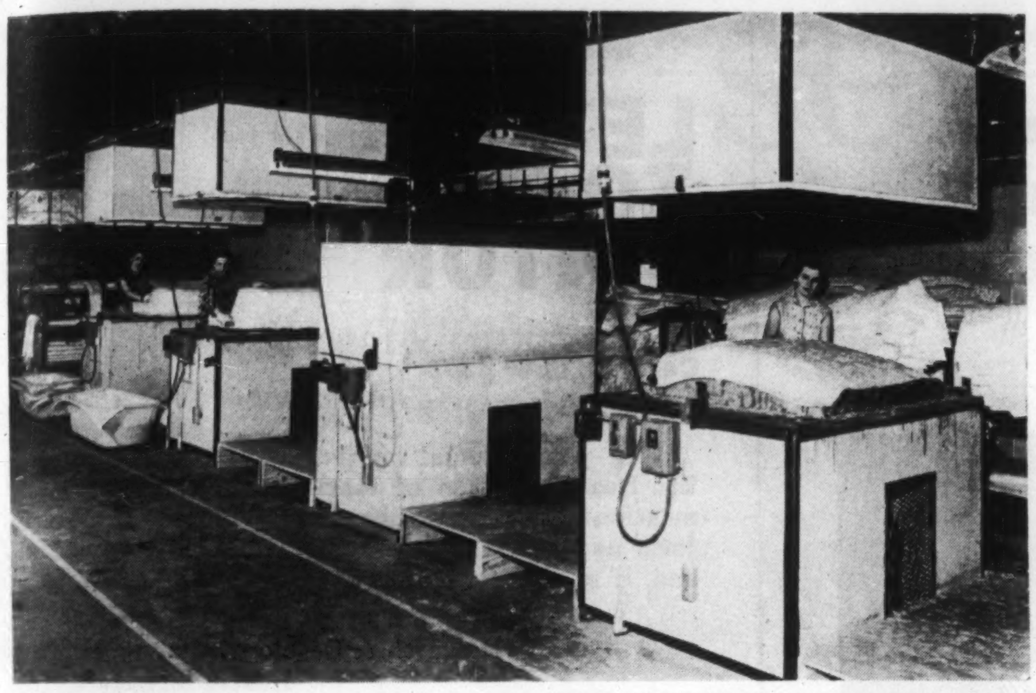
More education

The conference also brought out the fact that a major inducement to the design engineer in choosing a job is the opportunity to continue his graduate education. When companies provide for such a program, one of the rewards is stability of employment among engineers. A significant example of the validity of this statement was the Westinghouse experience. This company pays half the tuition fee for each course successfully completed. As a result, during the recent strike, fewer enginers left the company than during normal periods.

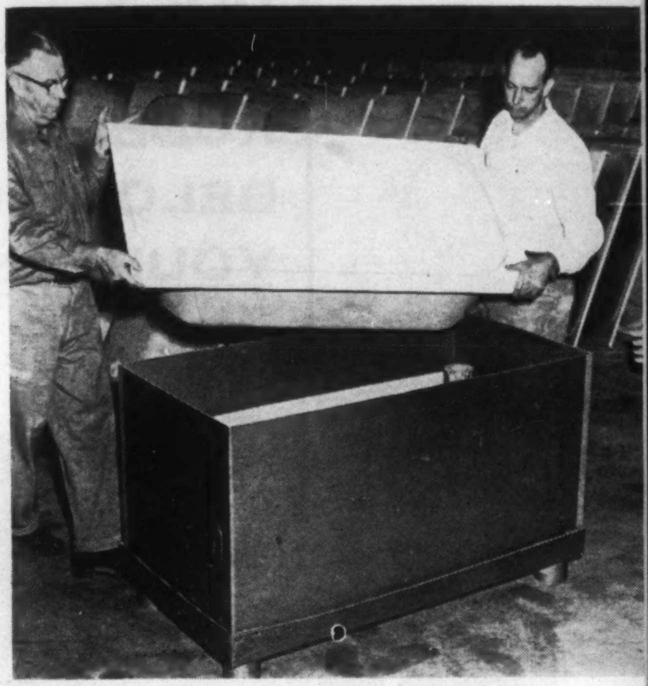
Engineers attending the conference were also told that an important factor making for success in a job is the engineer's grasp of economics. The speaker emphasized that an engineer with a lack of knowledge of economics may not bear in mind the budget he has to work with nor the market possibilities of the product he is designing.



Demonstrations *like this were an added attraction at most company booths.*



Preform machines *Low cost of manufacturing equipment, minimum floor space and accuracy of glass distribution are obtained by preforming mat. Several layers of mat are used with a polyester binder. Seams in preforms are overlapped for strength and no seam is located directly over another.*



Finished tub, *though made from fiberglass reinforced plastics, is porcelain-like in appearance.*

Preforming, mold temperature control allow . . .

Rapid Molding of Reinforced Plastics Structures

■ A unique mold construction coupled with a novel preforming operation makes possible the rapid production of reinforced plastic structures of practically unlimited size and depth of draw. Developed by Sterling Precision Corp. of Toledo, Ohio, the new matched-die molding process also allows the user to achieve close dimensional tolerances and uniform physical integrity throughout a structure.

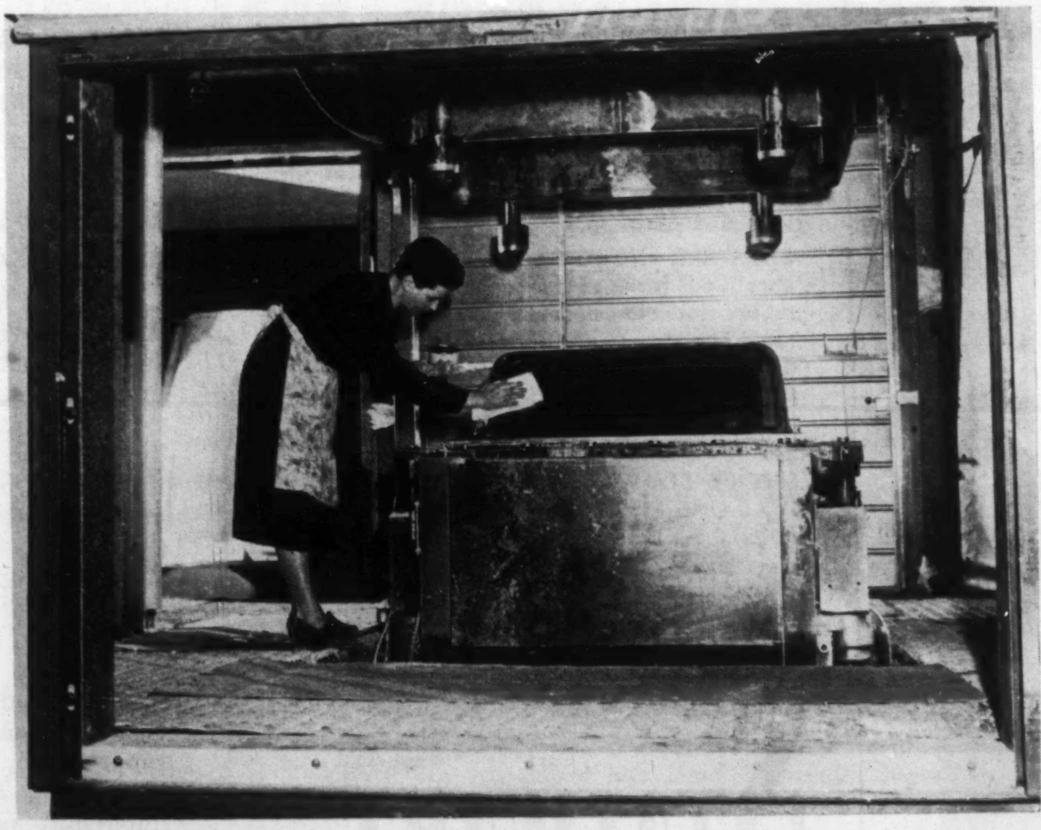
Mold design

The matched-die mold has one metal face and one plastics face. Stainless steel sheet, which can be heated by electrical resistance, is formed to the shape required for one die surface. A synthetic elastomer is vulcanized to the back of the sheet to provide insulation and to allow for differential contraction and expansion between the sheet and its supporting structure.

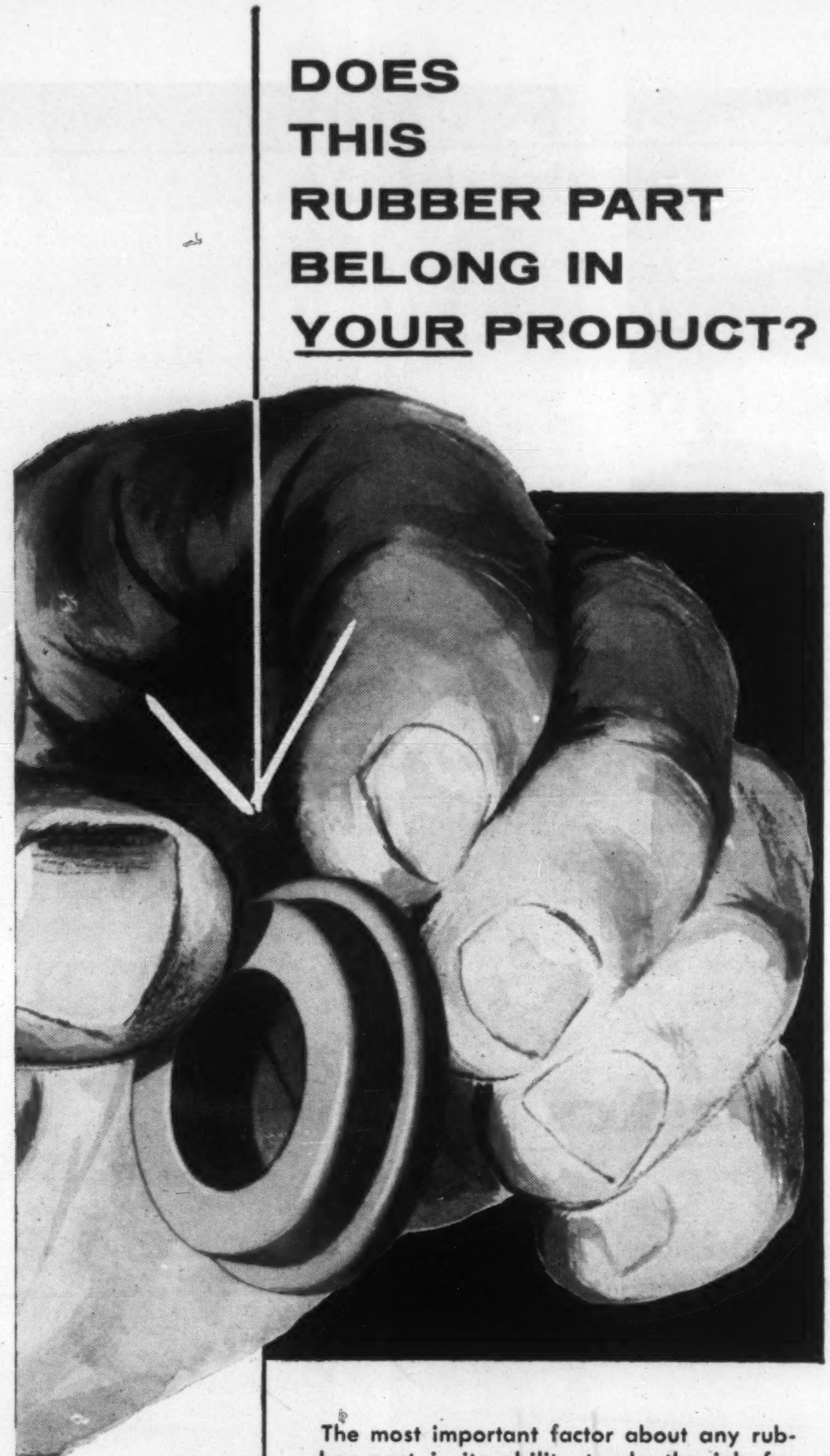
The supporting structure consists of aluminum filled epoxy resin heated to 200 F by an imbedded water circulatory system. This epoxy substructure is supported by a structural steel member designed to control deflection within close limits under operating pressures.

The mating epoxy die is cast to a high temperature wax lay-up on the steel mold surface. Accuracy of part thickness depends

(continued on p 208)



Bathtub mold *Mold release is being applied to a bathtub mold made of mirror finished stainless steel.*



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LETTERS TO THE EDITOR

Ceramic fiber paper

To the Editor:

In your manual on industrial textile fibers in the Dec 1955 issue of MATERIALS & METHODS, you mention that ceramic fibers are available in a felted form as paper. Is this material currently available and, if so, from whom might we obtain it?

R. P. FORSBERG, Supervisor
Research & Development Laboratories
Hexcel Products, Inc.
Oakland, Calif.

At the present time ceramic fiber paper can be obtained from three sources: The Carborundum Co., Johns-Manville Corp. and Babcock & Wilcox Co. Additional information on ceramic fiber paper was given in another article in the Dec 1955 issue, "Four Inorganic Papers," starting on p 98.

Manuals available

To the Editor:

I read, with great interest, your manual entitled "Pressure Sensitive Tapes" in the Mar 1956 issue of MATERIALS & METHODS. It was a fine treatment of the subject. . . .

Would you please send me a bibliography of these M&M Manuals so that I may catch up on what appears to be excellent reading material?

BRANDON B. PUSEY
Bakelite Co.
Bound Brook, N. J.

We were happy to forward a list of those M&M manuals still available. Anyone interested in this list can obtain it by writing to our Reader Service Dept.

What makes a ceramic?

To the Editor:

Noted in the April, 1956, issue of MATERIALS & METHODS was a statement regarding ceramics which is erroneous. The statement in question appeared under "Materials Outlook", as follows:

"Plastics production will triple in this country by 1975 according to one authority. Today's production of 3.6 billion pounds was achieved in just 15 yr and approximates or exceeds that of materials such as copper, zinc, natural fibers, rubber, aluminum, ceramics and leather."

The error involves including ceramics in this comparison, as will become obvious. During a typical year in the period 1950-1952 the production of the ceramic products such as Portland cement, structural clay products, glass and gypsum products was reported to be 176 billion pounds per year. These figures do not include a great variety of other important ceramic products for which no weight statistics were available, including ceramic whitewares, electrical ceramics, abrasives, porcelain enameled products and others. The production of all

(continued on p 232)

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Students and foreign subscribers (other than Canadian), please request literature directly from manufacturers.

MANUFACTURERS' LITERATURE

New Literature

Dispersions. Acheson Colloids Co., Div. of Acheson Industries, Inc., 4 pp, Lists 41 colloidal and semi-colloidal dispersions for operational functions, maintenance, lubrication, machine design and other industrial applications. (1)

High Speed Tools. Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pittsburgh 22, Pa., 16 pp, 17 charts. Expanded edition of "The Working of Tool and High Speed Tools." Request from Sales Dept., Allegheny Ludlum.

Sintered Stainless Parts. Alloy Metal Powders, Inc., 4 pp. "Operational Steps in Producing Sintered Parts From Stainless Steel Powders." (2)

Lubricating Coatings. Alpha Molykote Corp., 4 pp, illus. New technical house organ, "Lubrication Newsletter." Lead story discusses press fitting with molybdenum disulfide lubrication. (3)

Polyethylene and PVC Pipe. American Agile Corp., 12 pp, illus. Catalog of corrosion resistant polyethylene and polyvinyl chloride pipe, tubing ducting, valves and fittings. (4)

Wire Rope. Hazard Wire Rope Div., American Chain & Cable Co., Inc., 24 pp, illus., No. DH-129D. "Wire Rope Recommendations for Industrial Services." (5)

Alumina Ceramics. American Lava Corp., 4 pp, illus., No. 562. Advantages of AlSiMag alumina ceramics for electron tube applications. (6)

Phosphor Bronze. American Brass Co., 1 p, illus. Describes Anaconda's Duraflex, a fine grain phosphor bronze said to have an endurance limit 30% higher than ordinary phosphor bronze. (7)

Iron Powder Cores. Arnold Engineering Co., 12 pp, illus., No. PC-109. History, properties, types of electronic iron powder cores. Includes MPA Tentative Standard 11-56T. (8)

Steel Pipe, Tubing. Babcock & Wilcox Co., Tubular Products Div., 6 pp, No. TDC-163A. Condensed technical data on various tubing alloys that have proved satisfactory in high temperature service. (9)

Electroplating with Rhodium. Baker & Co., Inc., 113 Astor St., Newark 5, N. J., 19 pp, illus. "Data and Directions for Electroplating with Rhodium." Request from G. R. Briechle, Baker & Co.

Metallurgical Carbons. Barnebey-Cheney Co., 1 p, No. J-35. Chemical and physical characteristics of metallurgical carbons. (10)

Beryllium Copper Springs. Beryllium Corp., 4 pp, No. 33, illus. How Berylco beryllium copper springs are used in a vibration damping device for mounting electronic components in aircraft. (11)

Alloy Sheet Metal Parts. S. Blickman, Inc., Weehawken, N. J., 29 pp, illus. Guide for purchasing alloy sheet and light plate fabrication. Request from S. Blickman, Inc., on company letterhead.

Ferrous Castings. Campbell, Wyant & Cannon Foundry Co., 24 pp, illus. Describes facilities for producing gray iron and steel castings, and pictures a variety of actual production parts. (12)

Wire Cloth. Cambridge Wire Cloth Co., 4 pp, illus. New quarterly house organ on woven wire conveyor belts, industrial wire cloth and other woven wire products. (13)

Surfactants. Carbide & Carbon Chemicals Co., Div. of Union Carbide & Carbon Co., 40 pp, illus. Data on Tergitol surfactants, describing seven nonionics and four anionics. Performance data on wetting, penetrating, cleaning and sudsing action, and lime soap dispersing powder. (14)

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Stainless Wire. Carpenter Steel Co., Web Wire Div., 2 pp, illus. Advantages and specifications for Blue Label Type 302 stainless wire for springs and similar parts. (15)

Aluminum Castings. Centr-O-Cast & Engineering Co., 4 pp, illus. Shows typical products: permanent mold, semi-permanent, centrifugal and centrifuge aluminum castings. Sizes range from 2 oz to 65 lb. **(74)**

Strong Cap Screws. Cleveland Cap Screw Co., 4 pp, illus. Describes Kaufman double extrusion process for making cap screws. Advantages include smooth flowing internal grain structure and ability to hold close tolerances. (16)

Refractories. Climax Molybdenum Co., 6 pp, No. Cdb-7. Covers two molybdenum carbides, Mo_2C and MoC, and the two molybdenum nitrides, Mo_2N and MoN. Also contains a section on multicarbide systems, of which the TiC-Mo_2C system appears to have the greatest potential industrial importance. (17)

Wire. Sigmund Cohn Corp., 24 pp, illus. Catalog of small and unusual ribbon and wire, including potentiometer wire; electroplated, etched or coated wire; and Wollaston process wire. (18)

Printed Circuit Laminates. Continental Diamond Fibre Div., Budd Co., Inc., 4 pp, illus. Copper-clad paper-base, epoxy glass-base and Teflon glass-base laminates for standard etched-circuit production. Grades, sizes, properties and tolerances. (19)

Die Casting Small Parts. DCMT Sales Corp., Div. of British Industries Corp., 23 pp, illus. Catalog explaining techniques used in high speed die casting of small parts. (20)

Metal Stamping. Dayton Rogers Mfg. Co., 23 pp, illus. Describes a small lot metal stamping service "with lowest possible die costs." (21)

Silicone-Based Finishes. Dow Corning Corp., 4 pp, illus. Design and maintenance advantages for silicone-based finishes. Formulations are classified as "straight" silicone, "modified" silicone and "siliconized," with case histories showing usefulness of each type. (22)

Nickel Electrical Alloys. Driver-Harris Co., 94 pp, charts, No. R-56. Comprehensive catalog of special electrical and resistance alloys and fine gage nickel alloy wire and strip. Contains conversion tables, definitions, ASTM specifications. (23)

Neoprene. Elastomers Div., E. I. du Pont de Nemours & Co., Inc., 8 pp, illus. Latest issue of "Neoprene Notebook" has article on the meaning of "heat resistance" in rubber plus information on new neoprene applications. (24)

Industrial Radiography. E. I. du Pont de Nemours & Co., Inc., 24 pp, illus. X-ray films, chemicals and screens for industrial radiography. Charts evaluate basic characteristics of Du Pont x-ray films and give optimum processing recommendations. (25)

Stainless Steel. Eastern Stainless Steel Corp., 4 pp, illus. Describes Type 321 SW grade of sheet and plate resulting from new method of melting ingots. (26)

PVC Pipe. Easton Plastic Products Co., Inc., 9 pp. Three bulletins: chemical resistance of Easton polyvinyl chloride pipe; specifications on pipe and fittings; and instructions for threading, cutting and assembling Easton PVC pipe and fittings. (27)

Electrolytic Chromium, Manganese. Electro Metallurgical Co., Div. of Union Carbide & Carbon Corp., 4 pp, illus. Properties of electrolytic chromium and manganese. Also ferrous and nonferrous applications. (28)

Stainless Steel Castings. Empire Steel Castings, Inc., 4 pp, No. 556-C. Chart for 23 corrosion resistant stainless steels lists specifications, analyses, physical properties and uses. (29)

Welding Materials. Eutectic Welding Alloys Corp., 140 pp, illus., No. TIS 2575. Pocket data book featuring simplified welding procedures for all base metals. Covers 120 welding rods, electrodes and welding compounds. (30)

Glass Pipe, Fittings. Fischer & Porter Co., 4 pp, illus. Pyrex brand glass tubing for laboratory or pilot plant use and other special services. (31)

Metallized Ceramic Coating. Frenchtown Porcelain Co., 4 pp, illus. Data on Molcote, metal-to-ceramic coating, that may be hard soldered up to 2200 F. (32)

Tool Materials. Carboloy Dept., General Electric Co., 4 pp, illus., Nos. GTO-102, GT-311. Sizes and shapes of cemented oxide grade 0-30, holders and accessories. Also specifications for high titanium, nickel binder, grade 330 finishing carbide, including blanks for cylindrical and square boring tools. (33)

Epoxy-Polyamide Resins. General Mills, Inc., 9 pp, graphs, No. 11-6-3. Data on thermosetting compositions based on polyamide resin 115 and epoxy resin. They are considered promising for solventless adhesives that adhere to glass, plastics, wood and metals; for low pressure, glass-reinforced moldings for tool and die castings; and for embedment of electronic components. (34)

Plastic-Faced Plywood. Georgia-Pacific Plywood Co., 14 pp, illus. Advantages of GPX plastic-faced plywood used for cabinets, industrial counters, assembly line tables, etc. (35)

Brazed Construction. Handy & Harman, 4 pp, illus., No. 72. Applications of Easy-Flo, a low temperature silver brazing alloy. (36)

Metal Cleaning. Hanson-Van Winkle-Munning Co., 4 pp, illus., C-108. Application of Matawan cleaners in preparing metallic surfaces for electroplating, anodizing and other protective coatings. (37)

Welding Positioner. Harnischfeger Corp., 2 pp, illus., No. P-22. Describes Model UP-1000 that permits easy rotation of weldments up to ½ ton in weight. (38)

Investment Casting Alloys. Haynes Stellite Co., Div. of Union Carbide & Carbon Corp., 40 pp, illus. Outlines design data developed in more than ten years' experience in producing investment castings. Also describes 26 alloys selected from more than 300 tested under actual production conditions. (39)

Insulating Material. Hays Mfg. Co., 12 pp, illus., No. 100. Properties of Haysite, a glass-reinforced alkyd-base polyester insulating material designed to meet rigid electrical standards. (40)

Balsa Wood. International Balsa Corp., 19 pp. Factual report on balsa wood, its growth, production, processing and uses. (41)

Heat Treating Ductile Iron. International Nickel Co., Inc., 8 pp, illus. Outlines commercial processes for developing tensile strengths of 60,000 to 150,000 psi and elongation as high as 25% in ductile iron castings. (42)

Insulations. Johns-Manville, 20 pp, illus. Catalog of thermal insulations and refractories for temperature control from —400 to 3000 F. (43)

Aluminum Extrusions. Kawneer Co., Aluminum Mill Products Div., 4 pp, illus. Describes completely integrated (pig through extrusion) facilities for producing shapes, rod, bar and tubing. (44)

Electrical Tapes. Kendall Co., Polyken Sales Div., 4 pp, No. P6-1. Polyethylene, vinyl, plastic-coated cloth and cloth tapes for electrical applications. (45)

Adhesives. Koppers Co., Inc., Chemical Div., 8 pp, illus., No. C-6-230. Physical and chemical properties and various uses of resorcinol-formaldehyde compositions known as Penacolite Brittle Resins. (46)

Iron-Like Wood. Lignum-Vitae Products Corp., 16 pp. Mechanical and industrial applications of lignum-vitae, a hard tropical wood with a density almost equal to that of iron. It is noncontaminating, acid and chemical resistant, and self-lubricating. (47)

Paint Selector. Logo, Inc., 1 p. Guide to selection of paints for polystyrene. Lists type of application, finish and thinner. (48)

Castings. Meehanite Metal Corp., 4 pp, illus. Reprint tells how cost of special pattern making can be eliminated by ordering cast bar stock in standard sizes. (49)

Adhesives, Coatings, Sealers. Minnesota Mining & Mfg. Co., 14 pp. Pocket folder listing Government specifications for adhesives, coatings and sealers and the 3M products that meet these requirements. (50)

Solvent Detergent. Oakite Products, Inc. Folder on Oakite Composition No. 98. Designed for power washers, this solvent detergent simultaneously cleans and protects metal against rust. (51)

Pressure Pipe Insulation. Owens-Corning Fiberglas Corp., 4 pp, illus., No. IN1.C7. Physical properties, thermal

Manufacturers' Literature

performance and limitations of Fiberglas Low Pressure Pipe Insulation for temperatures from 50 to 250 F. (52)

Small-Mesh Expanded Metal. Penn Metal Co., Inc., 4 pp, illus. Sizes, dimensions and weights of Minimesh, a small-mesh expanded metal used for guards or grilles on stoves, heaters, radios and coin-operated phonographs. (53)

Marking Stainless Steel. Photo Chemical Products, 5 pp. Describes Ateenate process for producing permanent jet black markings on stainless steel. Markings withstand corrosive fumes, lubricants, abrasives, solvents and chemicals. (54)

Powder Metal Parts. Powdercraft Corp., 6 pp, illus. Advantages of the metal powder process in manufacturing machine parts and bearings. (56)

Temperature Measurement. Pyrometer Instrument Co., Inc., 8 pp, illus., No. 175. Catalog of optical, micro-optical, radiation, immersion, surface and indicating pyrometers for precision temperature measurements. (57)

Precision Metal Parts. REF Mfg. Corp., 10 pp, illus. Facilities for producing precision parts and assemblies for aircraft and electronic use. (58)

Stainless Steel Tubing. Republic Steel Corp., Steel & Tubes Div., 12 pp, illus. Technical points to be considered when purchasing or specifying welded stainless steel tubing. (59)

Casting Aluminum. Reynolds Metals Co., Desk PR4810, 2500 S. Third St., Louisville, Ky., 130 pp, illus., 23 tables. Design and production of aluminum castings. Clear, concise information on how to select casting processes and aluminum alloys. Request from Reynolds on company letterhead.

Metal Fabrication. Risdon Mfg. Co., 34 pp, illus. Features Risdon's main products, small metal components and assemblies. Case histories show how components made in two or three parts have been redesigned and reduced to one unit. (60)

Centrifugal Castings. Shenango-Penn Mold Co. Five bulletins on centrifugal castings. Detailed alloy chart shows comparative specifications, chemical analyses and minimum physical properties of Shenango nonferrous alloys. (61)

Silicone Release Agents. Silicones Div., Union Carbide & Carbon Corp., 8 pp, illus. Effectiveness of silicones as release agents in shell mold casting. (62)

Flexible Teflon Tubing. Sparta Mfg. Co., 4 pp. Properties and characteristics of Teflon thin-walled and spaghetti tubing. Suggested uses include: instrument tubing, electronic applications, wire sheathing, acid lines, steam or other high temperature lines. (63)

Titanium Forgings. Steel Improvement & Forge Co., 4 pp, illus., No. 7. Discusses hydrogen in titanium forgings and shows new applications for forged titanium. (64)

Hot Die Stampings. M. Swift & Sons, Inc., 1 p. Color performance chart for hot die stamping of plastics, leather, wood, satin, paper and rubber. (65)

Molding Compounds. Thermaflow Chemical Corp. File folder containing information on high impact polyester (alkyd) glass fiber-reinforced molding materials. Lists physical properties, product applications, molding conditions and techniques. (66)

Seamless Steel Tubing. Tube Reducing Corp., 4 pp, illus. Data on Rockdrawn small diameter, seamless steel tubing. Sizes range from ⅛ to 1⅜ in. o.d. in a wide variety of wall thicknesses in carbon, alloy and stainless steel. (67)

Wrought Iron Fittings, Flanges. Tube Turns, Div. of National Cylinder Gas Co. Folder on wrought iron welding fittings and flanges, made in sizes from ½ to 12 in. Lists physical properties and typical applications. (68)

Aluminum Coating. Turco Products, Inc. Information on an aluminum surface coating process that meets MIL-C-5541. Stops aluminum corrosion, insures paint adhesion and provides an ornamental finish. (69)

Vacuum Melting. Utica Metals Div., Utica Drop Forge & Tool Corp., 8 pp, illus. Production and testing equipment, and progress made by Utica in taking vacuum melting out of the laboratory and into production. (70)

Stainless Steel Sheet. Washington Steel Corp., 12 pp, illus. Care and use of Type 430 MicroRold stainless steel sheet. Physical properties and analysis, relative corrosion resistance, fabrication and application. (71)

Plastics Moldings. Whitso, Inc., 14 pp, illus. Describes custom molded nylon and other plastics components for the electrical industry. (72)

Powder Metal Products. Yale & Towne Mfg. Co., Powdered Metal Products Div., 16 pp, illus. How Powdermet parts permit close tolerances, good wearability, controlled porosity and high ductility. Shows production facilities and typical products. (73)

Other Available Literature

Irons & Steels • Parts • Forms

Centrifugally Spun Tubes. American Cast Iron Pipe Co., 4 pp, illus. Stock list of centrifugally cast tubes furnished as-cast, rough machined or finish machined. (75)

Alloy Steels. Armco Steel Corp., 32 pp, illus. Graphic description of quality control from raw material to finished steels. (76)

Wire Parts, Metal Stampings. Art Wire & Stamping Co., 4 pp, illus., No. 875. Shows the variety of wire parts and small metal stampings this company can produce. (77)

Investment Castings. Austenal Laboratories, Inc., 12 pp, illus. Describes Microcast process and charts representative properties of investment cast alloys. (78)

Forged Steel Rings, Flanges. Standard Steel Works Div., Baldwin Lima-Hamilton Corp., 12 pp, No. 10,000. Design advantages and cost-cutting applications of forgings in industrial processing equipment. (79)

Nickel Plated Steel. Bart Mfg. Corp., 6 pp, illus. Developed during World War II for atomic purposes, Bart Lectro-Clad pipe now controls corrosion in water systems, in natural gas production and in the pulp and paper, organic chemical and inorganic chemical fields. (80)

Low Alloy Steel. Bethlehem Steel Co., 66 pp, illus., No. 353. Properties and features of Mayari-R steel for use in applications requiring high strength and good wear and corrosion resistance. (81)

Specialty Steels. Carpenter Steel Co., 32 pp, illus. A guide to tool and die steels, stainless steels; silicon and nickel alloys; special purpose alloy steels; valve, heat resisting, and super alloy steels; tubing and pipe; and fine wire specialties. (82)

Chrome-Moly Electrode. Champion Rivet Co., 13 pp, No. CM-55. Low hydrogen welding electrodes for chromium molybdenum alloy steels. Data include physical and mechanical properties of welds, chemical analysis of weld deposit, and a discussion of welding procedure. (83)

Circular Steel Shapes. Commercial Shearing & Stamping Co., 24 pp, illus., No. P-3. Covers range of cold formed circular steel blanks, flanged and dished shapes, produced from stocked dies. (84)

Stainless Steel Castings. Cooper Alloy Corp., 8 pp, No. 55. Information on stainless steels: comparison of material casting factors, mechanical properties of cast stainless steel, and extensive corrosion data. (85)

Perforated Steel Sheets. Cross Engineering Co., leaflet, illus. Shows variety of designs available and typical uses of perforated steel sheets for ventilation, concealment, decoration and protection. (86)

Specialty Steels. Crucible Steel Co. of America, 32 pp, illus., No. TM9. Information on cold rolled specialty steels, including stainless, alloy and carbon spring steels. Also hardness conversion numbers, decimal equivalents and weight-size tables. (87)

Manufacturers' Literature

To obtain literature listed on these pages, use the convenient prepaid post card on pp 67 and 68.

Static and Centrifugal Castings. Duraloy Co., 16 pp, illus., No. 3354-G. Describes facilities for producing high alloy static and centrifugal castings. Data on castings for heat, corrosion and abrasion resistance. (88)

Gray Iron. Gray Iron Founders' Society, Inc. Data Sheet and 12-pp booklet. Data sheet summarizes gray iron specifications. Booklet contains articles on how and when to use gray iron, and its adaptability for casting. (269)

Steel Extrusions. H. M. Harper Co., 16 pp, illus. Covers production of extrusions from stainless steels, heat resistant alloys, titanium, alloy steels, carbon steels and specialty bronzes. Glass lubricant assures inexpensive dies, rapid die changes and economical extrusion of difficult alloys. (89)

Sponge Iron Powders. Hoeganaes Sponge Iron Corp., 6 pp, illus. Outlines principles of powder metallurgy and role of sponge iron powder in this process. (90)

Precision Springs. Spring Div., Hunter Spring Co. Selected data sheets dealing with basic considerations in the design of precision springs. (91)

Powder Metallurgy Handbook. International Powder Metallurgy Co., Inc., 28 pp. Concise data on all aspects of the powder metallurgy process. (92)

Powder Metallurgy. Keystone Carbon Co., 6 pp, folder. Describes powder metal products and production facilities. (93)

Wire. Keystone Steel & Wire Co., 12 pp, illus., No. 1a, Ke. Illustrates the various kinds of wire available and provides information about the cold heading operation. (94)

Steel Bar. La Salle Steel Co., 20 pp, illus. Data and charts on properties of a high strength, free machining bar. (95)

Clad Steels. Lukens Steel Co., 6 pp, illus. Price comparison of clad steels and solid high alloys. (96)

Malleable Iron. Malleable Founders' Society, 4 pp, illus., No. 52. New facts on the uses of malleable iron. (97)

Stainess Steel Castings. Ohio Steel Foundry Co., 4 pp, illus., No. 651-C. Compositions of Fabrite stainless steels for casting and illustrations of numerous corrosion resistant castings. (98)

Forgings. Pittsburgh Forgings Co., 4 pp, illus. Pictures forgings made for the automotive industry. (99)

Investment Casting. Precision Metalsmiths, Inc., 12 pp, illus. Answers questions on precision castings and contains a comprehensive table of investment casting alloys and their properties. (100)

Deep Drawn Parts. Pressed Steel Tank Co., 16 pp, illus. How industries have been helped in quality production at low cost by use of Hackney Metal containers and deep drawn component parts. (101)

Steel Tubing. Sawhill Tubular Products, Inc., 16 pp. Information on grades and size range of company's steel tubing. (102)

Zinc Coated Steel. Sharon Steel Corp., 12 pp, illus. Physical properties of a hot-dipped, zinc-coated, strip steel. (103)

Steel Castings. Steel Founders' Society of America, 4 pp, illus., Product Design Study No. 71. How a complex one-piece compressor cylinder was cast in steel. (104)

Precision Forgings. Titusville Forge Div., Struther Wells Corp., 8 pp, illus. Describes facilities for precision forging of parts regardless of size, metal or alloy. Shows numerous parts produced. (105)

Stainless Strip. Superior Steel Corp., 32 pp, illus. Technical information on 20 types of stainless strip steel. Includes table on weight per lineal foot of strip steel for various thicknesses and widths. (106)

Wire Processing. Sylvania Electric Products, Inc., 12 pp, illus. Facilities for manufacture of fine wire and ribbon and wire and ribbon parts. Chemical composition charts of materials used are included. (107)

Steels. Timken Roller Bearing Co., Steel & Tube Div., Canton, Ohio. Complete catalog of steels. Request from Timken on company letterhead.

Small Precision Metal Parts. Torrington Co., 4 pp, illus. Shows various small precision metal parts custom-made by the Specialties Div. (108)

Stainless and High Alloy Tubing. Trent Tube Co., 48 pp, illus. Classifies types of tubing, giving typical applications, physical, chemical and electrical properties for each. Information on welding, bending and installation techniques. (109)

Fine Seamless Tubing. Uniform Tubes, 4 pp, illus. Covers a complete line of fine seamless tubing available in sizes from 0.10 to ⅝ in. o.d. and in metal of almost any analysis. (110)

Steel Castings. Unitcast Corp., illus., No. 649A. Discusses testing facilities for insuring high quality production of steel castings. (111)

Constructional Alloy Steel. U. S. Steel Corp., illus. "U. S. Steel Presents T-1" gives properties and fabrication data for new high strength, weldable steel with exceptional toughness. (112)

Tool Steel. Vanadium-Alloys Steel Co., 68 pp. New tool steel guide, data on more than 50 types of tool steel and cold finished products. (113)

Ferroalloys and Metals. Vanadium Corp. of America, 24 pp, illus. "The Vancoram Review" presents technical articles on applications and developments in ferro metallurgy especially concerned with vanadium alloys. (114)

Stampings. WLS Stamping Co., 4 pp, illus. Describes high speed, low cost stamping process using "speed tooling" method. (115)

Pipe and Tubing. Wallingford Steel Co., 8 pp, illus. Stainless, carbon and alloy steel tubing for ornamental, mechanical, pressure, sanitary and aircraft use in size range from ¼ to 3 in. o.d. (116)

Stainless Steel Castings. Waukesha Foundry Co., 4 pp, illus., No. WF-5. Facilities for producing any hard-to-shape type of stainless steel castings. (117)

Stampings. Wells Aluminum Products Co., Inc., 22 pp, illus. Facilities for stampings, dies and engineering service. (118)

Electric Weld Tube Mills. Yoder Co., 64 pp, illus. Reviews the different tube making processes and gives complete description of the cold forming, electric welding process—its development, its possibilities and its limitations. Also discusses initial and operating costs of such mills, production speed, and minimum tonnage or footage required for profitable operation. (119)

Mechanical Tubing. Youngstown Sheet & Tube Co., 4 pp, illus. Features size and wall thickness of a complete line of Yoloy electric weld mechanical tubing. (120)

Nonferrous Metals • Parts • Forms

Die Castings. Advance Tool & Die Casting Co., 8 pp, illus. Facilities for producing die castings to specifications. (122)

Special Shaped Alloy Wire. Alloy Metal Wire Div., H. K. Porter Co., 4 pp, illus., No. T-2. Describes special shaped alloy wire and tabulates properties. (123)

Aluminum Pipe. Aluminum Co. of America, 18 pp, illus. Aluminum pipe characteristics and advantages for each of its major fields of application. (124)

Aluminum, Stainless Steel. Aluminum Goods Mfg. Co., Contract Div., 21 pp, illus. "Service to Industry" lists wide variety of component parts made for government and industry. Technical services and finishing and fabricating facilities are also described. (125)

Engineering Bronzes. American Crucible Products Co., 12 pp, illus. Includes complete data on facilities, technical information, case histories and applications of Promet bronzes. (126)

Prefinished Metals. American Nickeloid Co., 24 pp, illus. Describes fabrication techniques, uses and properties of prefinished metals. Also gives case histories of applications in various manufacturing fields. (127)

Titanium Foil. American Silver Co., Inc., Technical Data Sheet No. 100. Thin gage, commercially pure titanium foil rolled to close tolerance. Includes tolerance chart, mill limits, mechanical and electrical properties and suggested applications. (128)

Zinc. American Zinc Institute, Inc., 32 pp, illus. How metallic zinc coatings, pigments and anodes provide economical control of corrosion. (129)

Precision Casting Process. Morris Bean & Co., 4 pp, illus. Describes Antioch process for producing castings that

Manufacturers' Literature

meet wave guide specifications in all bands. (130)

Duplex Tubing. Bridgeport Brass Co., 14 pp, illus., No. 1954. Explains use of Duplex tubes for heat exchangers and condensers in which internal and external corrosion conditions differ. (131)

Sintered Bronze. Bunting Brass & Bronze Co., 12 pp, illus., No. 56P. Information on stock bearings, flange stock bearings, washers and bars made of sintered bronze. (132)

Bimetals. W. M. Chace Co., 36 pp, illus. Describes and explains 22 uses of bimetals as actuating elements in temperature responsive devices. (133)

Phosnic Bronze. Chase Brass & Copper Co. Bronze alloy for jobs requiring high strength metal with good conductivity. (134)

Magnesium, Aluminum Castings. Eclipse-Pioneer Div. Foundries. "Book of Facts" shows company's facilities for custom making aluminum and magnesium castings. (135)

Aluminum Designation System. Peter A. Frasse & Co., Inc. Conversion chart for new designation system. (136)

Aluminum Forgings. Harvey Aluminum Div., 12 pp, illus. Describes aluminum press forgings, impact extrusions and hand forgings. Outlines mechanical properties of aluminum forging alloys and summarizes typical forging applications. (137)

Investment Castings. Investment Casting Co., 12 pp, illus. Second edition explains how investment casting is used to eliminate machining and assembly costs and minimize waste metals. (138)

Metal Powder Parts. Johnson Bronze Co., 4 pp, illus. Illustrates self-lubricating bearings, bushings and structural parts made of iron and bronze powdered metals. Includes table of alloys with composition and average physical properties. (139)

Aluminum Conductors. Kaiser Aluminum & Chemical Corp., 20 pp, illus. Discusses various types and sizes, and tabulates cost comparisons and efficiencies. (140)

Rare Earths. Lindsay Chemical Co., 12 pp, illus. Describes company's work in the rare earth field. (141)

Lithium Metals, Compounds. Lithium Corp. of America. Data sheets on properties and uses of lithium metal and organic and inorganic lithium compounds for metal treatment, ceramic modifications, welding, etc. (142)

New Titanium Alloy. Mallory-Sharon Titanium Corp., 4 pp. Properties of MST 6AL-4V, a high stability titanium alloy for use at temperatures to 750 F. Includes heat treating data and stability test results. (143)

Die Castings. Monarch Aluminum Mfg. Co. File data on aluminum and zinc die castings and aluminum mold castings showing applications, advantages and facilities for making them. (144)

Precision Investment Castings. National Precision Casting Corp., 4 pp, illus. Case histories of savings effected by using investment casting for small or intricate parts. (145)

To obtain literature listed on these pages, use the convenient prepaid post card on pp 67 and 68.

Brass Powder Parts. New Jersey Zinc Co., 4 pp, illus. Describes applications of brass powder parts in self-developing cameras, rotors, drive bars. (146)

Precious Metal Wire. J. M. Ney Co., 2 pp. Technical data on advantages of using Ney-Oro 6, precious metal wire for pivots in instrument bearings. (147)

Small Zinc Die Castings. Page & Hall Mfg. Co., Inc., 4 pp, illus. How the zinc die casting process reduces tool and part cost. Brief design guide included. (148)

Precision Castings. Ohio Precision Castings, Inc., 12 pp, illus. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium copper plaster mold castings. (149)

Die Castings. Parker White Metal Co. Engineering data on die cast component parts. (150)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, illus. Describes Phoenixspun methods for spinning spherical and extra deep-drawn contours. (151)

Die Castings. Precision Castings Co., Inc., 24 pp, illus. Describes integrated facilities for quantity production of aluminum, magnesium and zinc die castings. (152)

Roll Formed Shapes. Roll Formed Products Co., 26 pp, illus. Shows simple and complex sections produced from both ferrous and nonferrous metals. (153)

Zinc Die Castings. St. Joseph Lead Co., 25 pp, illus. Discusses role of zinc as a base metal for die casting alloys and lists the variety of commercial finishes for zinc base die castings. (154)

Centrifugal Castings. Sandusky Foundry & Machine Co., 6 pp, illus. Specification chart for ferrous and nonferrous alloys for centrifugal castings. (155)

Light Metal Castings. Thompson Products, Inc., 8 pp, illus. Describes a complete line of precision die castings for various industrial uses. (156)

Bimetallic Construction. Arthur Tickle Engineering Works, 8 pp, illus. Describes Alumibond process for molecularly bonding aluminum and its alloys to iron and steel and their alloys. (157)

Sintered Bearing Alloys. U. S. Graphite Co., Div. of Wickes Corp., 6 pp, illus., No. 18. Discusses design and metallurgical requirements for selection of sintered metal bearings. (158)

Aluminum Wire. U. S. Rubber Co., 30 pp, tables. Handbook on the uses and properties of aluminum for power and lighting wire. (159)

Brazing Alloys. United Wire & Supply Co., 3 pp, illus. Wire brazing aluminum for low temperature brazing of various metals and alloys. (160)

Castings and Patterns. Wellman Bronze & Aluminum Co., 16 pp, illus., No. 53. Facilities for producing nonferrous castings and wood or metal patterns. (161)

Spun Tubing. Wolverine Tube Div., 28 pp, illus. Advantages and numerous applications of the spun end process for nonferrous tube. (162)

Light Metal Forgings. Wyman-Gordon Products Corp., 4 pp, illus. Announces the availability of large size light alloy forgings, particularly those of magnesium and 7075 aluminum. (163)

Nonmetallic Materials • Parts • Forms

Plastics Pipe, Fittings, Valves. American Hard Rubber Co., 6 pp, illus., No. 80-A. Corrosion resistant plastics pipe with good impact strength and toughness. Physical properties, chemical resistance tables and installation and fabrication data. (165)

Corrosion Proof Cements. Atlas Mineral Products Co., 12 pp, No. 5-2. Latest data on five standard corrosion proof cements: furan, phenolic, sulfur, polyester and silica based materials. (166)

Plastics and Resins. Bakelite Co., 12 pp, illus. Condensed reference file of Bakelite plastics and resins with information on properties and uses. (167)

Thermoplastics. Bassons Industries Corp., 12 pp, illus. Complete data on reinforced and formed plastics. Illustrates processing facilities. (168)

Porous Media. Refractories Div., Carborundum Co., 55 pp, illus. Data on Aloxite aluminum oxide porous media for various applications. (169)

Polyethylene Sheeting. Celanese Corp. of America, 6 pp, NP-13. Physical and chemical properties of polyethylene sheeting for tank linings, molded items, ducts, etc. (170)

Felt. Continental Felt Co., Inc., 10 pp, illus. A history of felt, some of its countless uses in machinery and a description of the company's facilities. (171)

Plastics Pipe. Corning Glass Works, 12 pp, illus. Physical properties, uses and specified dimensions of PVC pipe and fittings. (172)

Synthetic Elastomers. Fabrics Div., E. I. du Pont de Nemours & Co., Inc., 7 pp, illus. Properties and uses of various grades of Fairprene elastic composition for sheet stock, coated fabrics and adhesives. (173)

Plastics Film. E. I. du Pont de Nemours & Co., Inc., Film Dept., 8 pp, illus. Latest commercial uses and detailed physical and chemical properties of Mylar. (174)

Plastics Extrusion, Injection Molding. E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept. Describes extrusion and injection molding of Alathon polyethylene resins. (175)

Industrial Textile Fibers. E. I. du Pont de Nemours & Co., Inc., Textile Fi-

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bers Dept., 20 pp. Consideration of synthetic fibers as industrial materials. Includes rayon, acetate, nylon, Orlon, Dacron, Teflon fibers. (176)

Felt. Felters Co., 22 pp. Design properties, selection and applications of felt and felt products. (177)

Polyvinyl Chloride. Firestone Plastics Co., 8 pp. Mechanical, thermal, electrical and chemical resistance properties of unplasticized polyvinyl chloride. (178)

Reinforced Wood. Gamble Bros., Inc., 4 pp. Why wood coated with high strength thermoplastic has increased impact resistance and durability. (261)

Ceramics. General Ceramics Corp., 4 pp. Selection chart for electrical and mechanical properties of a wide range of ceramics. (262)

Plastics Designs. General Electric Co., Chemical & Metallurgical Div., illus. Two booklets, "The Plastics Story" and "Fabricated Silicone Rubber Parts," describe case histories and latest applications. (179)

Vinyl Tubing. Gering Products, Inc., 4 pp, illus. Folder on Ger-Flex, a transparent, nontoxic, vinyl plastic flexible tubing that cannot corrode. (180)

Graphite. Graphite Specialties Corp., 4 pp, No. GS 101-1. An impervious graphite, more than 99.5% pure carbon for high temperature parts. Chemical resistance data and physical properties including heat effects to 5700 F are charted. (181)

Insulation Hardboard. Great American Industries, Inc., Rubatex Div., 16 pp, illus. Design data for building insulation applications of Rubatex Hardboard (expanded synthetic rubber compound). (182)

Rigid Polyvinyl Chlorides. Kaykor Industries, Inc., Div. of Kaye-Tex Mfg. Corp., 6 pp. Chemical and physical properties of Vyflex rigid polyvinyl chloride plates and sheets. (183)

Glass. Libbey-Owens-Ford Glass Co., 8 pp, illus. Glass in product and engineering design. (184)

Prime Coated Pressed Wood. Masonite Corp., 2 pp, illus. Properties and uses of Presdwood panels with hard, tough primer coat applied by special process at factory. (185)

Refractory Porcelain. McDanel Refractory Porcelain Co., 36 pp, illus. Catalog of high temperature porcelain products with physical, mechanical and electrical properties. (186)

Alkali Hardwood Lignin. Mead Corp., 14 pp. Outlines properties, industrial applications and chemical modifications of "Meadol." (187)

Adhesives, Coatings, Sealers. Minnesota Mining & Mfg. Co., 4 pp, illus. Describes use of adhesives, coatings and sealers for sealing joints and bonding and protecting sheet metal in manufacturing and construction. (189)

Fire Resistant Hydraulic Fluid. Monsanto Chemical Co., 20 pp. Describes hydraulic fluid that reduces fire hazards and has operating qualities of petroleum fluid. (190)

Glass Bonded Mica. Mycalex Corp. of America, 24 pp, illus. Design information for parts to be machined from glass bonded mica. (191)

Carbon Parts. Ohio Carbon Co., 4 pp, illus. Thermal, mechanical and electromechanical properties of company's carbon parts. (192)

Carbon Graphite. Pure Carbon Co., Inc., 32 pp, illus, No. 52. Technical data on description, properties, applications and specifications of Purebon carbon graphite. (193)

Plastics Sheets, Tubing. Pyramid Plastics, Inc. Price list and data on plastics tubing, pipe, rod, sheets and fittings. (194)

Molded Plastics. Richardson Co., 12 pp, illus. Describes types and grades of laminated and molded plastics. Applications given. (195)

Plastics Molding. Romar Plastics, Inc., 4 pp, illus. Describes facilities for all stages of plastic molding. (196)

Synthetic Rubber Compounds. Rubber & Plastics Compound Co., Inc., 4 pp, illus. Complete data on Nervastral Seal-Pruf, a synthetic rubber flashing and membrane waterproofing sheet, and Nerva-Plast, a cold setting waterproofing cement. (197)

Ceramic Insulation. Star Porcelain Co., 3 pp. Specifications on center shoulder bushings, insulating washers and bushings made of steatite ceramic. (198)

Rubber Parts. Stillman Rubber Co., 24 pp, illus. Typical products and facilities for making custom molded rubber parts. (199)

Reinforced Plastics. Strick Plastics Corp., 4 pp, illus. Describes reinforced polyester laminate with good thermal, electrical, chemical and mechanical properties. Typical applications given. (200)

Polyurethane Foam. Surface Chemicals, Inc., 4 pp. Properties of Isothane foam for thermal insulation and sound control. (201)

Rubber Engineering Data. Tyer Rubber Co. Illustrates molded and extruded rubber products and provides technical specifications and relative properties of natural rubber, Buna S, Buna N, neoprene, butyl, Thiokol and silicone. (202)

Metal Plywood Laminate. U. S. Plywood Corp., 8 pp, illus. Gives special features, advantages and wide variety of uses for Armoply, sheet metal-bonded plywood. (203)

Plastic Resins, Compounds. Naugatuck Chemical Div., U. S. Rubber Co., 8 pp, illus. Vinyl, polyester and elastomeric resins and compounds, applications, properties and processing. (204)

Plastics Pipe. National Tube Div., U. S. Steel Corp., 28 pp, illus., No. 24. Data on unplasticized rigid polyvinyl chloride pipe, both normal and high impact types. Describes installation techniques. (205)

Flexible Plastics Tubing. U. S. Stoneware Co., 28 pp, illus. Properties and uses of extruded vinyl plastic tubing available in semi-rigid or flexible sheets, tubing or solid cord. (206)

Nylon Screws. Weckesser Co., 3 pp, illus. Describes black nylon screws and nuts and use in design problems. Gives price list for various types. (207)

Felt. Western Felt Works, 28 pp. Discussion of felt, its applications, composition, specifications and testing methods. (208)

Extruded Plastics. Western Textile Products Co., Extruded Plastics Div., 4 pp, illus. Describes company experience and shows special problems solved. (209)

Finishes • Cleaning and Finishing

Barrel Finishing. Abbott Ball Co., 8 pp, illus. Describes barrel finishing techniques with a new design tumbling barrel. (211)

Ceramic Coating. California Metal Enameling Co., 4 pp, illus. Ceramic coatings for metals for high temperature service. Includes sample of ceramic coated 0.001-in. stainless and steel foil. (263)

Protective Coatings. Ceilcote Co., 8 pp, illus. No. C-150. Gives base formulations, chemical properties and adhesion characteristics of seven standard organic coatings. Includes simplified chart for selecting coatings, surface treatment, processes, etc. (212)

Decorator Flock. Cellusuede Products, Inc., 10 pp, illus. Describes flock, what it is, how it is used and how it is applied. (264)

Metallic Coatings for Plastics. Coating Products. Attractive brochure describes the various coatings applied to plastics materials. Samples included. (213)

Brush Plating. Dalic Metachemical Ltd., 4 pp, illus. Presents advantages of brush plating with the Dalic process. (214)

Vinyl Lacquers. Davison Chemical Co., Div. of W. R. Grace & Co., 5 pp. Technical bulletin on use of Syloid 244 for flatting vinyl lacquers to give a low gloss effect. (215)

Phosphate Coating. Detrex Corp., 6 pp, illus. Describes low cost phosphate coating process that protects iron and steel from corrosion. (216)

Abrasives. Elgin National Watch Co., 4 pp, illus. Describes Dymo-C, a diamond abrasive for finishing carbide dies. (217)

Spray Painting Equipment. Finish Engineering Co., Inc., 16 pp, illus. Describes pressure formed spray painting masks and auxiliary equipment. (265)

Bright Nickel Plating. Harshaw Chemical Co., 4 pp, illus. Advantages of Nubrite bright nickel plating process. (266)

Barrel Finishing. Lord Chemical Corp., 40 pp, illus. Handbook on precision barrel finishing of metals, metal alloys and plastics. (218)

Protective Coatings. Magic Chemical Co. Revised catalog describes "Magic-Vulc" abrasion resistant rubber lining and its applications. (219)

Enamel. Maas & Waldstein Co., 2 pp, No. 520. Data sheet for industrial multicolor enamels. (220)

Corrosion Prevention. Metallizing Engineering Co., Inc., 4 pp, illus. Description of Metco Systems and how

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these pure metallized zinc or aluminum coatings prevent corrosion. Typical applications shown. (221)

Silicone Base Finish. Midland Industrial Finishes Co. Brochure describes silicone-base finish, said to resist heat at 500 F without discoloration. (222)

Barrel Finishing. Minnesota Mining & Mfg. Co., 12 pp, illus. How barrel finishing works, when to use this process, and what operations barrel finishing performs. A supplementary booklet discusses abrasive chips and compounds for barrel finishing. (223)

Wrinkle Finishes. New Wrinkle, Inc., illus. Folder shows typical products utilizing Wrinkle finishes. (231)

Brushing. Osborn Mfg. Co., 10 pp, illus. Describes advantages of industrial brush finishing operations through case histories. (224)

Blast Cleaning, Dust Control. Pangborn Corp., 16 pp, illus., No. 226. Describes various models of "Continuous-Flo Rotoblast" barrels available for production line blast cleaning to reduce cleaning costs. (225)

Tar Base Protective Coatings. Pittsburgh Coke & Chemical Co., Protective Coatings Div. Five bulletins give detailed information concerning Pitt Chem 100 Series of tar-base protective coatings. (226)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead.

Metal Finishing. Promat Div., Poor & Co., 4 pp, illus. Explains Pre-Galv process of controlling galvanizing operations by use of only one addition to each of the pickle and flux operations. Result is superior, controlled galvanizing, longer acid life, controlled dross formation and improved appearance. (227)

Paint Spray. Ransburg Electrocoating Corp., 16 pp, illus. Description of electrostatic spray paint process for automatic industrial applications. (228)

Electroplated Palladium and Platinum. Technic, Inc. Data sheet describes physical and electrical properties for both metals. Includes corrosion data, specifications, and thickness requirements. (229)

Porous Chromium Coatings. Van der Horst Corp. of America, 12 pp, illus. Describes oil retaining, wear resistant chromium coating for bearing surfaces, cylinder walls and other applications where hard wear and lubrication are factors. (230)

Methods and Equipment

Carbon Dioxide Welding. Air Reduction Sales Co., 13 pp, illus. Carbon dioxide shielded consumable electrode arc welding described with operating characteristics and specific properties. (232)

Heat Treating. Ajax Electric Co., 8 pp, illus, No. 500. Traces development of austempering and martempering, discusses principle of S-curve, and gives instructions for selecting specific heat treatment. (267)

To obtain literature listed on these pages, use the convenient prepaid post card on pp 67 and 68.

Muffles, Retorts. Electro-Alloys Div., American Brake Shoe Co., 6 pp, illus., No. T-239. Describes company's high heat-resistant muffles and retorts and outlines corrosion and abrasion resistance features. (233)

Silver Brazing. American Platinum Works, 16 pp. Manual on selective fluxing for low temperature silver brazing. (234)

Welding Insert. Arcos Corp., 10 pp, illus. Insert allows butt welding to be done on one side only. (270)

Black Light. Black Light Corp. of America, 65 pp, illus. Long wave ultraviolet light for display, industrial inspection and flaw detection. Case histories plus data on research in this field. (236)

Bolts, Nuts, Screws. Buffalo Bolt Co., Div. of Buffalo Eclipse Corp., 101 East Ave., North Tonawanda, N. Y., 150 pp, No. 51. Comprehensive guide for purchasing bolts, nuts and screws, includes blueprints, specifications and prices. Request from Buffalo Bolt Co. on company letterhead.

High Vacuum Equipment. Consolidated Vacuum Corp. Price list of high vacuum equipment, accessories. (268)

Electroforming. Gar Precision Parts, Inc., 4 pp, illus. Process permits exact reproduction of intricate details on sheet or complex forms using permanent or expendable mandrels. (237)

Fasteners. General Tire & Rubber Co., illus., folder. Self-mounting fasteners for shock-mounting metal, plastic and glass panes and components. (238)

Metal Powder Tester. Haller, Inc., 2 pp. Testing machines for powder metal parts and tools for making standard test specimens. (239)

Heat Treating Furnaces. Hevi Duty Electric Co., 8 pp, illus., No. 653. Describes furnaces for annealing, stress relieving, nitriding, etc. (240)

Salt Baths. E. F. Houghton & Co., 32 pp, illus. Tabulates data and gives physical properties and uses of various types of salt baths. (241)

Furnaces. C. I. Hayes, Inc., 44 pp, illus., No. 112. Complete data on a variety of furnaces for hardening, tempering, carbonitriding, forge heating, sintering, annealing and tool heat treating, as well as on atmosphere generators and ammonia dissociators. (242)

Radiography. High Voltage Engineering Corp., 25 pp, illus. Importance of radiography as an inspection and quality control tool. Case studies are included. (243)

Carbon Control. Leeds & Northrup Co., 10 pp, illus., No. Td4-620(2). Principle and operation of automatic measurement and control of active carbon inside furnace retorts during heat treating cycles. (244)

Electrodes, Holders. P. R. Mallory & Co., Inc., Welding Div., 2 pp, illus., No. 8-11. Advantages, design and application of 8-deg ⅝-dia spot welding electrodes and holders. (245)

Tubular Furnaces. Marshall Products Co., 4 pp, illus. Discusses both the creep test and tensile test models of Marshall tubular furnaces, as well as control panels and radial brackets. Includes specifications. (246)

Induction Heating. Ohio Crankshaft Co. Describes plant survey and possible applications to which induction heating might be put for greater production economy. (247)

Hardness Testers. Riehle Testing Machines, Div. of American Machine & Metals, Inc., 4 pp, illus., No. RH-1154. Portable hardness testers for Rockwell readings with scales A, B, C, D, F and G. (248)

Lock Screw Fasteners. Russell, Burdsall & Ward Bolt & Nut Co., 3 pp, illus. Advantages and dimensions of spinlock screws. (249)

Tensile Testing Machines. Scott Testers, Inc., 6 pp, illus., No. 55. Shows wide assortment of testing machines for determining tensile strength of materials such as rubber, paper, wire and thread. (250)

Set Screws. Set Screw & Mfg. Co., 24 pp, No. 19. Lists prices and dimensional information. (251)

Heat Treating Equipment. Stanwood Corp., 4 pp. Brief description of types of heat treating equipment with suggested applications. (252)

Abrasion Tester. Taber Instrument Corp., 4 pp, illus., No. 5409. Tester evaluates resistance of surfaces to rubbing abrasion. Includes tests of painted, lacquered, electroplated surfaces and plastic coated materials. (253)

Electric Furnaces, Controls. Thermo Electric Mfg. Co., 20 pp, illus., No. 55. Electric furnaces, temperature controllers and hot plates for industrial use. (254)

Modern Testing. Tinius Olsen Testing Machine Co., 25 pp, illus. Anniversary issue traces major advances in design of testing and balancing equipment since 1880. (255)

Resistance Welding. Unitek Corp., 6 pp. Describes bench mounted precision resistance welder for joining small metal assemblies such as instruments and electronic and ordnance products. (256)

Heat Treating Furnaces. Waltz Furnace Co., illus. Contains descriptive material on all types of industrial furnaces for heat treating, enameling, cyaniding and annealing in controlled and regular atmosphere. (257)

Welding Process. Westinghouse Electric Corp., 7 pp, No. B-6525. Performance and applications of consumable electrode inert gas welding process. (258)

Hardness Testers. Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. Engineering data, uses and design features of Rockwell hardness testers. (259)

One point of view

Science and Politics Do Not Mix

After three years of investigations, tests, dismissals, reinstatements, hearings and rehearings, the famous battery additive case involving the National Bureau of Standards and its chief, Dr. Allen V. Astin, is apparently closed. By a vote of 4 to 0, the Federal Trade Commission has dismissed charges of false advertising against the manufacturer of a battery additive which is claimed to give better operation and longer life to lead-acid storage batteries.

Such is the ending of a case that from start to finish has done irreparable harm to the engineering and scientific profession. The first damaging blow came when Secretary of Commerce Weeks challenged an adverse finding on the battery additive by the National Bureau of Standards. Secretary Weeks called on Dr. Astin to resign. There were immediate protests from many engineering and scientific organizations that Dr. Astin's nonpolitical job was being sacrificed to political pressures. After a special committee of eminent technical men verified the NBS findings, Secretary Weeks reversed his order for Dr. Astin's resignation and reinstated him.

But the harm had already been done. It left a lasting impression that if this sort of thing could happen once, it could happen again. It served notice to the engineers and scientists employed by the government that their work is not immune to the manipulations of politicians.

At the time, nevertheless, it appeared that the work and tests of the National Bureau of Standards had been vindicated. But the case was continued with more hearings before the Federal Trade Commission, and its final decision has turned the victory into a defeat. The FTC disregarded the findings of the National Bureau of Standards. In so doing it also, in effect, rejected the conclusions of the special committee of scientists who unequivocally supported the position of the NBS. Instead the FTC accepted the testimony given by 45 users of the battery additive who attested to the merits of the product. Their testimony was not based on controlled engineering tests. It was merely their personal opinion.

Thus, the FTC decision, in this case, leads to a dangerous implication—that hearsay evidence has greater validity than the data supplied by engineers and scientists. We know that the FTC does not really believe this. But the implication is clearly there and will certainly be cause for great concern among our technical professions.

Gun blast tube, *impeller and orthopedic brace are anodized with Alumilite Hard Coating for extra resistance to abrasion, corrosion and erosion.*

What you should know about

Anodized Coatings for Aluminum

- *Types of treatments*
- *Properties*
- *Coloring and sealing*
- *Forming characteristics*

by R. V. Vanden Berg, *Aluminum Company of America*

■ Anodic oxidation (anodizing) of aluminum and its alloys produces surface coatings that are outstanding for their protective qualities. The physical and mechanical properties of these oxide coatings are totally unlike the metal itself. They display high resistance to corrosion and abrasion and provide high electric insulation to the underlying metal. This combination of properties, plus the ease with which they can be colored, accounts for the use of anodized coatings in a wide variety of aluminum products.

Thickness and density

Anodizing is an electrochemical method whereby the surface of aluminum is converted to an oxide when the metal is made the anode in certain electrolytes.

By proper control of the electrolyte and operating conditions, anodic coatings can be formed with definite characteristics. The coatings may be thin and dense or thick and porous. The degree of porosity determines the absorption characteristics of the coating and also affects its resistance to abrasion. Because of their density, coatings with a relatively small number of small diameter pores possess high abrasion resistance and will support high loads.

The overall thickness of the coating is generally determined by the total ampere-minutes of current used during the oxidation cycle, Fig 1. The weight of oxide formed per unit area, Fig 2, is a function of the thickness and porosity of the coating. Note the effect of electrolyte temperature on the coating weight.

The characteristic density or porosity of anodic coatings is usually expressed by a term known as the "coating ratio." This ratio is obtained by dividing the weight of anodic coating *formed* by the weight of the metal *removed.* As shown in Fig 3, higher coating ratios and denser coatings are obtained with dilute electrolytes and low electrolyte temperatures. In general, lower coating ratios are obtained with aluminum alloys than with pure aluminum.

Types of treatments

Electrolytes most commonly used in applying anodic coatings include sulfuric, chromic, and oxalic acids, and mixtures of sulfuric and oxalic acids. Alternating current may be used with all of these electrolytes; however, since the aluminum surface is the anode during only one half the cycle, the coating takes about twice as long to form.

Sulfuric acid anodizing with direct current is the most widely used anodic oxidation process. Coatings on pure aluminum are relatively hard and transparent and provide a glaze-like finish.

Anodic coatings produced in sulfuric acid electrolytes vary in appearance from transparent to translucent, depending on the alloy used. Films with a wide range of thickness and hardness may be produced by adjustment of acid concentration, temperature and time. A standard uncolored coating is produced in 15 to 18% sulfuric acid operated for 30 min at 71 F. Temperatures must be held to within 2 or 3 deg to produce a good coating. The process is operated at about 12 amp per sq ft and requires from 10 to 20 v ac.

Considerable variations in the manufacturing process may be made provided certain limits are held. The current tends to form oxide at the surface of the metal, whereas the acid electrolyte tends to dissolve the oxide so formed. Increasing the acid concentration or the temperature increases the attack on the oxide. While the effect of current density is less pronounced, the use of higher densities tends to counterbalance the rate of oxide dissolution. Films produced under conditions of higher solubility are softer, more porous, and somewhat more flexible than those obtained at lower temperatures and acid concentrations.

Anodic Coatings—Outside to Inside

The *first* formed oxide layer is located at the extreme outer surface of the coating. This layer is relatively porous compared to the rest of the coating since it is in contact with the electrolyte throughout the entire anodizing treatment.

As the reaction progresses, the oxide coating grows into the metal. The *last* formed oxide, known as the barrier layer, is a nonporous layer at the metal interface whose thickness is a function of the voltage and type of electrolyte used. Although this layer is very thin compared to the total coating, it has a marked effect on corrosion resistance and electrical properties.

The outstanding feature of the *intermediate* coating is its porosity. The size and number of the pores is a function of the formation voltage, the type and temperature of electrolyte and duration of treatment. The pores are oriented perpendicular to the metal interface and there are billions of them per square in. Despite their small diameter, they are large enough to permit penetration of the electrolyte and passage of current.

Chromic acid anodizing was first used to provide coatings with increased corrosion resistance. Based on the same time of anodic oxidation, the chromic acid process is more expensive, produces thinner coatings, and requires higher voltages than the sulfuric acid process. Generally there are fewer pores but they are larger in diameter than those in coatings formed in a sulfuric acid electro-

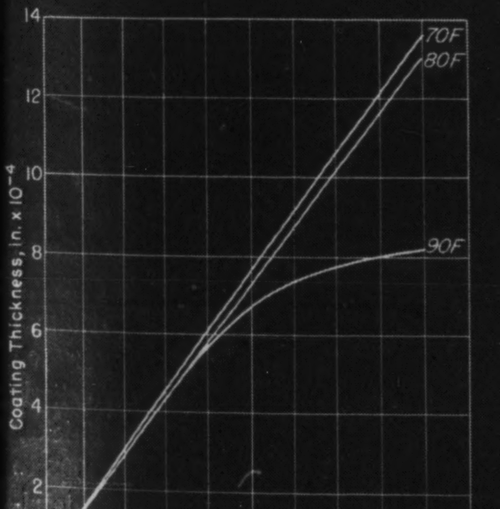


Fig 1 Effect of treatment time *and electrolyte temperature on coating thickness.*

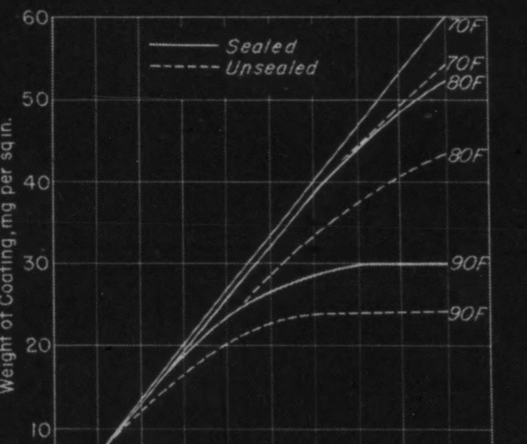


Fig 2 Unit weights *of sealed and unsealed coatings.*

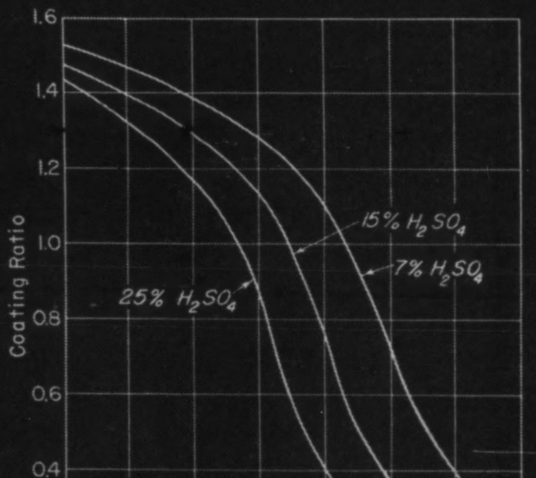


Fig 3 Effect of *various acid concentrations on coating ratio.*

lyte. Although the coatings are thin, they provide high resistance to corrosion because of the presence of chromium compounds in combination with a relatively thick barrier layer. Because of their thinness, chromic acid coatings have low abrasion resistance and a high degree of flexibility.

The chromic acid process is critical with respect to alloy composition and it is difficult to form films on certain alloys, particularly some casting alloys. Coatings have an opaque, slightly iridescent appearance.

Oxalic acid anodizing produces coatings which are essentially transparent. Film color varies from a light yellow to bronze. Coatings are dense with low color absorption capacity but possess high abrasion resistance. Mixed electrolytes of sulfuric and oxalic acids are sometimes used to produce effects somewhat similar to lowering the temperature of the sulfuric acid electrolyte, i.e., a denser coating with greater abrasion resistance.

Coloring anodic coatings

Due to the characteristic porosity of anodized coatings, organic coloring dyes and pigments can be absorbed in the pores to produce a wide variety of decorative effects. The coatings can also be impregnated with chromates or silicates for increased corrosion resistance. Also, light sensitive materials may be incorporated in the coatings to reproduce photographs by a process that is similar to that used with glass photographic plates.

Colored anodized coatings are unique in that the luster of the underlying metal imparts an attractive metallic sheen to the surface. By using different alloys and colorants, anodized coatings can be made to simulate such metals as gold, copper, bronze and brass. Aluminum-magnesium alloys such as 5357 or 6063 are usually used for these applications. To obtain maximum luster, surfaces should be buffed and electro- or chemically-brightened before anodizing.

Sealing anodic coatings

Most anodic coatings must be sealed to close the pores and render the coating non-absorptive. Sealing is usually accomplished by immersing parts in hot water or wet steam. It is generally thought that the oxide lining of the pore wall is converted from the amorphous to the monohydrate state with a subsequent increase in volume. This volume increase closes the pores and renders the coating impermeable, resistant to staining, and increases its protection against corrosion of the underlying metal.

In addition to hot water and steam, water solutions of chromates, silicates and phosphates are sometimes used as sealants. Oil, wax or graphite impregnation is sometimes required for specialized applications.

Since organic dyestuffs are soluble in water, colored anodic coatings cannot be sealed by conventional hot water methods. Consequently, sealants employed with organic dyestuffs are usually acetates of nickel or cobalt. The colloidal hydroxides produced by hydrolysis of the hot solution precipitate and seal the pores.

In some cases the absorbed dye may also react with the hot sealing solution to increase light fastness. Light fastness varies considerably and is a function of: 1) the dyestuff used; 2) techniques employed in the formation of the anodic coating; and 3) the concentration, temperature and pH control employed in the coloring and sealing steps.

Effect of alloying elements

The response of the different constituents of aluminum alloys to anodic oxidation varies considerably. Dissolution of a constituent during anodic treatment will leave voids that decrease the density of the coating and lower corrosion and abrasion resistance.

The insolubility of some constituents is often used to enhance the appearance of a coating. During anodic oxidation the silicon particles in aluminum-silicon alloys remain unchanged and in their original position. The attractive finish produced in gray aluminum architectural slabs is an example of this effect. The dark color produced in welded and brazed fillets of aluminum-silicon alloys subsequent to anodic treatment is also due to this effect.

In many cases the constituents of aluminum alloys will themselves oxidize and color the coating. The brown opaque appearance of alloys containing manganese is due to the presence of the manganese dioxide that is formed subsequent to anodizing. Oxidation also accounts for the yellowish tint of aluminum alloys bearing chromium constituents.

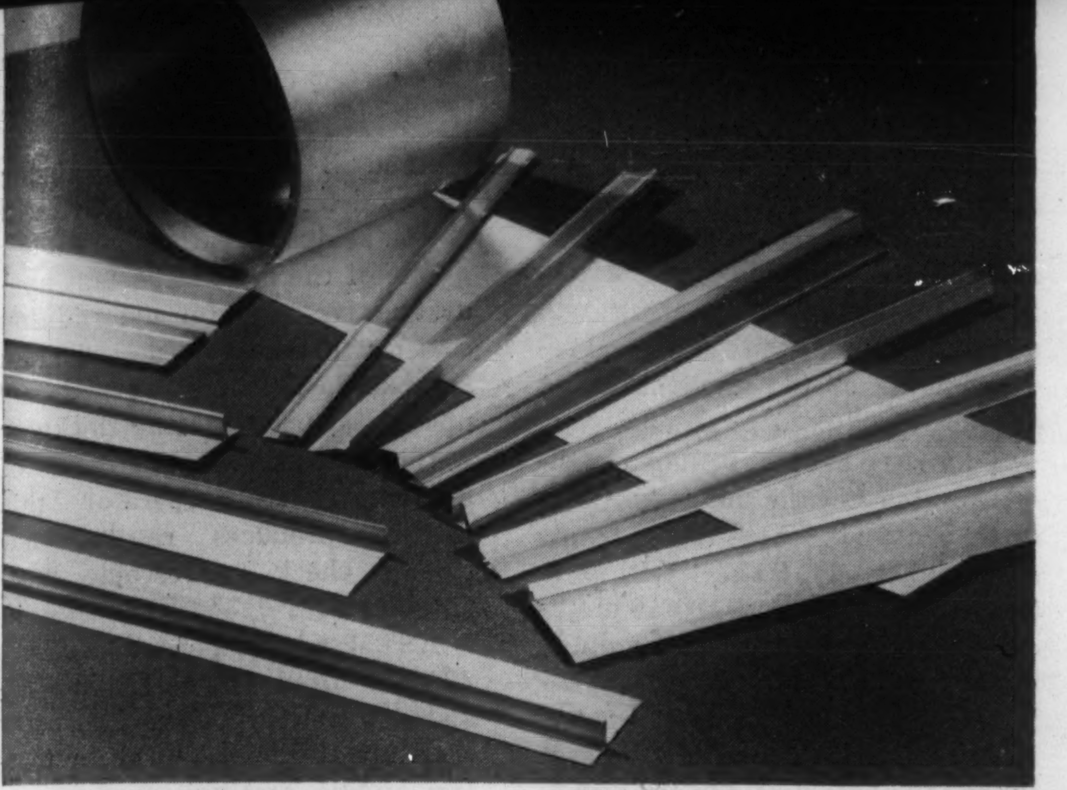
Generally, more continuous and transparent coatings are produced with the purer grades of aluminum. Super purity aluminum produces the most transparent oxide coating. Alloys such as 5357 and 6063 produce essentially transparent coatings with considerable metallic luster.

In assemblies containing more than one alloy, the alloys must be carefully selected to obtain a uniform overall appearance match. Castings and wrought products in the same assembly are undesirable. In some cases a surface pretreatment can minimize differences in appearance. Since anodic coatings reproduce the surface on which they are formed, an overall appearance match can often be obtained by applying a mechanical or etched texture to the surface before anodizing.

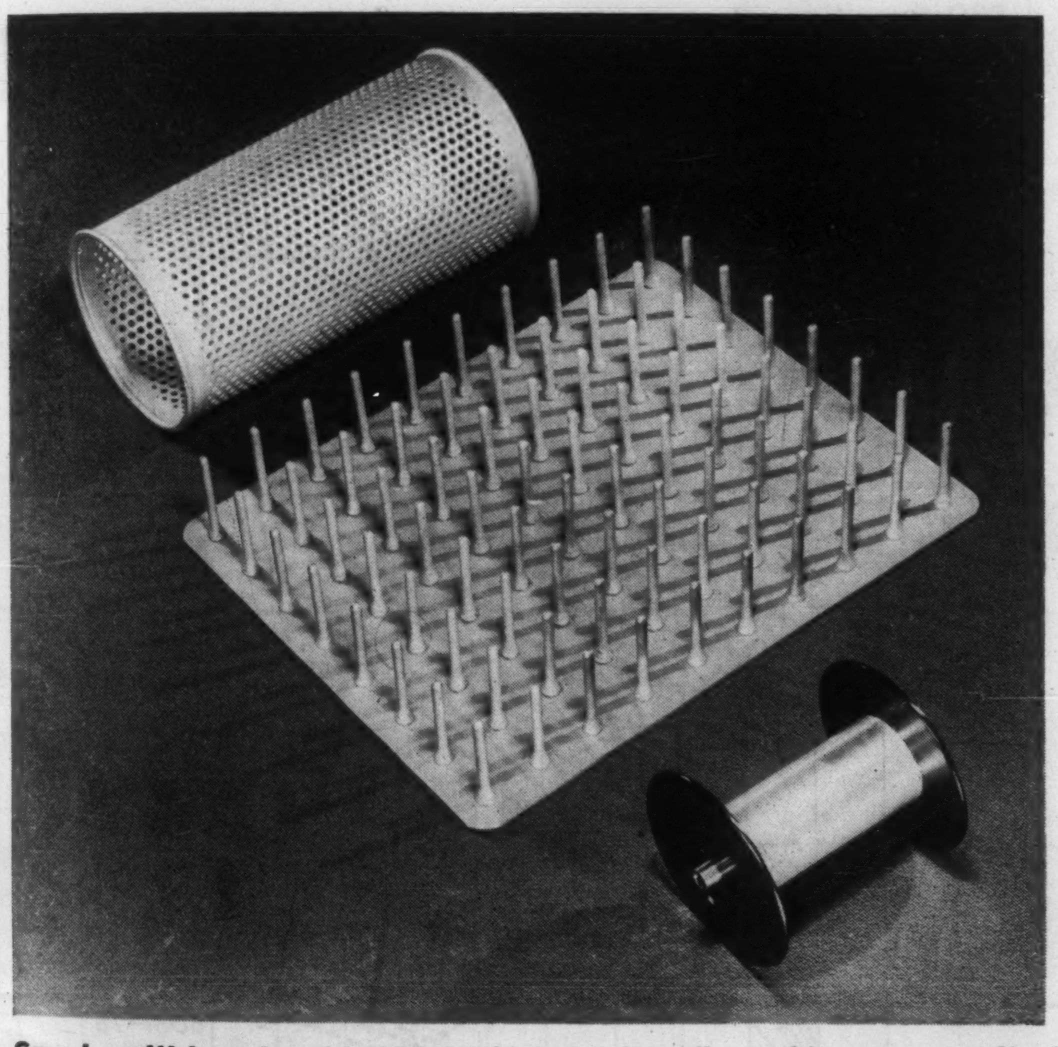
Effect of coatings on properties

Fatigue—When fatigue is critical design factor, a suitable allowance must be made for the reduced endurance limits produced by thick anodic coatings. Tests on specimens with conventional coatings indicate that a 0.0001 in. anodized layer on smooth surfaces will have little effect on fatigue strength. Thicker coatings in the range of 0.0003 to 0.0005 in. have a slight detrimental effect at high stresses.

Corrosion—The substantial corrosion protection provided by anodized coatings is due to a number of factors. Coating continuity is especially important. Since continuity is dependent upon the constituents present in the alloy,



Weather stripping sections *are roll formed from coil strip sheet subsequent to anodizing.*



Spool, quill board and bobbin *of high speed textile machinery are anodized to resist wear and abrasion.*

coatings on high purity aluminum are the most resistant to corrosion. Conversely, coatings on aluminum-copper alloys have low corrosion resistance.

In most cases, corrosion resistance can be substantially improved by sealing the coatings in a dichromate solution. Atmospheric exposure tests indicate that water sealed coatings with a thickness of 0.0004 in. or greater provide greatly increased weather resistance. This is important for architectural and other outdoor applications where preservation of original appearance is mandatory.

Insulation — Since aluminum oxide is a good dielectric, anodized coatings also possess good insulating properties. An example of this is the anodic film produced in boric acid electrolytes on the aluminum foil for capacitors. The voltage necessary to break down anodized coatings is generally proportional to coating thickness, a typical value being 600 v for a 0.006 in. coating on 1100 alloy. The breakdown voltage for hard coatings, such as Alumilite Hard and Martin Hard, is usually higher and has been measured at values up to 3,000 v on some alloys. It should be noted, however, that because of weak spots breakdown voltages may vary considerably on the same thickness of coating in the same alloy.

Hard coatings

Hard anodized coatings, produced by various proprietary techniques, are particularly advantageous where high resistance to abrasion, erosion and corrosion combined with light weight is required. Typical applications include helicopter rotor blade surfaces, pistons, pinions, gears, cams, cylinders, impellers and turbines.

The thickness of hard coatings ranges from 0.001 to 0.005 in., as compared to 0.0001 to 0.0019 in. for conventional coatings. The difference in weight of anodic coatings formed by conventional Alumilite and Alumilite Hard Coating processes is shown in Fig 4. Although the weight of hard coatings is much higher than conventional coatings, the order of the various alloys remains unchanged. Also, the abrasion resistance of these coatings is in the same order as the weight or density of coating. That is, the alloys with the densest coatings also have the highest abrasion resistance.

Forming of parts

Because of their brittleness, oxide coatings are usually subject to cracking during forming operations. For many applications cracking may not be objectionable, since it is usually difficult to detect by visual observation.

However, these fine cracks have an adverse effect on the bending properties of the metal and may cause fracture of the metal if bends are severe. In general, the thicker coatings formed in sulfuric and oxalic acid electrolytes will crack or craze to a much greater extent than oxide coatings formed in a chromic acid electrolyte.

It is very difficult to predict the success or failure of an anodized surface during forming. Simple bends on coated tube and sheet are possible. Roll forming is also possible and is used successfully to form anodized strip sheet into weather stripping. Despite this, a general recommendation cannot be made that all coated strip sheet will roll form successfully. Each application must be considered individually on the basis of the alloy used and sheet and coating thickness to determine if the anodic coating will adequately meet the functional requirements of the application.

Some Process Details

Holding devices or racks used for anodizing aluminum parts are different from those used in electroplating. Since the oxide coating is a dielectric, the initial surface electrical contact must be maintained throughout the anodic oxidation cycle. Also, the rack must be constructed from aluminum since other metals will dissolve in the electrolyte. For the same reason, aluminum assemblies containing other metals cannot be anodized.

Batch methods of applying anodized coatings are quite similar to those used in electroplating except that the parts are made the anode instead of the cathode. Bulk methods for applying anodized coatings, however, differ radically from electroplating methods. Small parts, such as rivets, washers and screws, are placed in perforated, nonmetallic cylindrical containers. Initial electric contact is maintained by exerting pressure on the mass of parts through a threaded center contact post. In addition to the batch and bulk methods, a continuous strip process is also used commercially to anodize aluminum sheet intended for such items as weatherstripping, food cans and containers.

Testing anodized coatings

There are several reliable methods for testing the quality of anodized coatings. These tests include ASTM B110-45, B137-45, B136-45 and B244-49T. The B110-45 method is based upon the voltage breakdown test as a means of determining coating thickness. Method B137-45 is based upon a chemical procedure for determining the weight of oxide coating. Method B-136-45 is a staining test to determine the effectiveness of the sealing treatment.

One of the most important nondestructive tests for determining coating thickness is described in B244-49T. This method is based upon measuring coating thickness with a Filmeter. In the hands of an experienced operator this method produces results that closely check microscopic measurements.

ASTM salt spray method B117-49T is used to determine resistance to corrosion. Humidity tests are sometimes used for testing anodic coatings used in refrigerator parts.

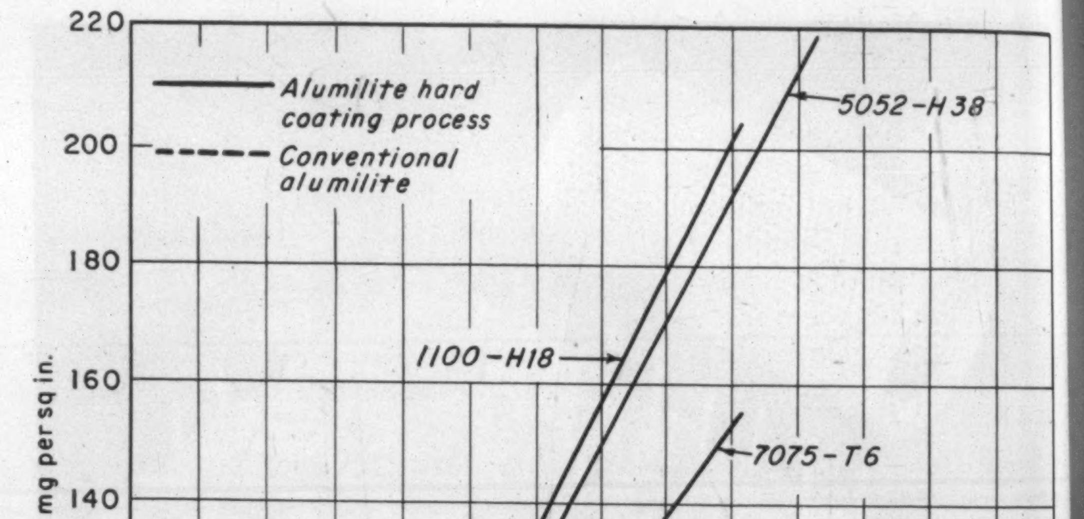
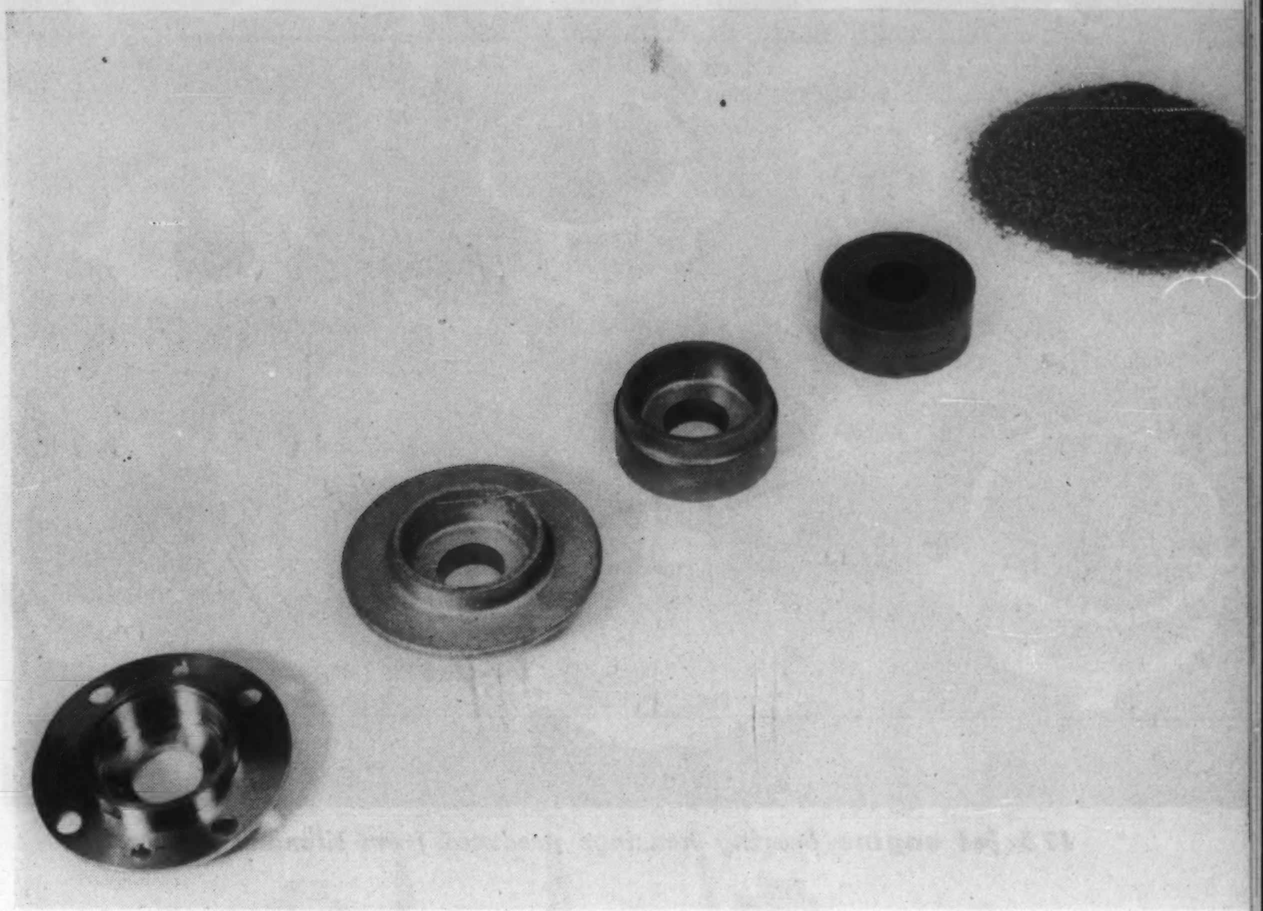


Fig 4 Comparison of coating weights *of typical aluminum alloys anodized by conventional and hard coating processes.*

By using press forming and hot pressing techniques to replace forgings, waste is reduced and production costs lowered by as much as 25%.



Steps in the production *of a bearing housing from a sintered titanium powder blank.*

Titanium Parts Made by Powder Metallurgy Methods

by George J. Wile, *Jet Engine Dept., General Electric Co.*

■ Fabrication of titanium parts by powder metallurgy methods saves money in the production of General Electric jet engine bearing housings. Cost estimates on volume production of one part indicate that this housing can be made for $14 per piece which is approximately 25% lower than the cost of the same part produced by forging.

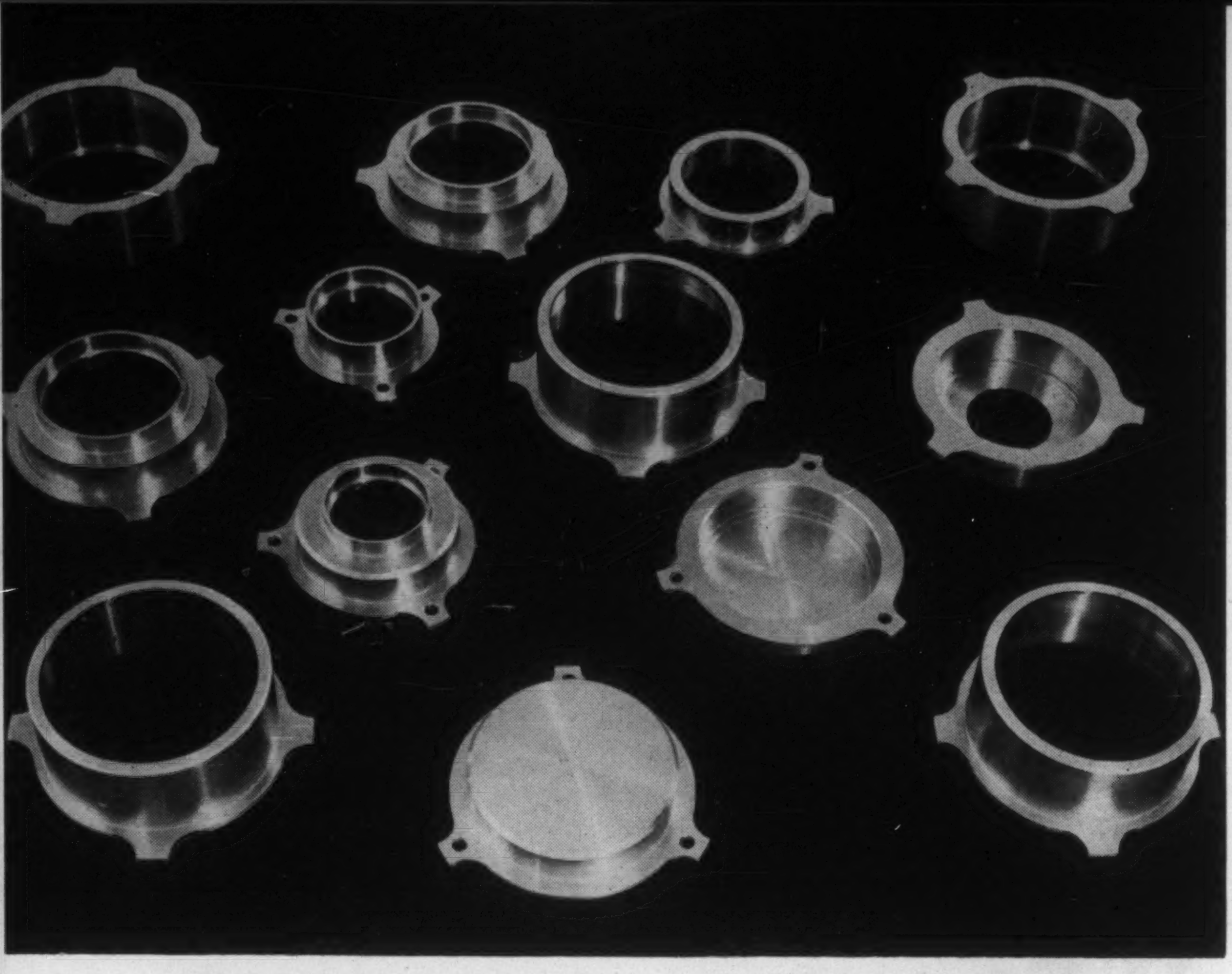
Press formed parts

A powder metallurgy process called the Clevite Press-Forming Process has been developed for high-volume, low-cost production. One of its outstanding advantages is a decrease in material utilization factor. Material utilizations as low as 1.2 lb of sponge to 1 lb of sintered, machined part are possible. Quantity production of the GE J73 bearing housing, PN 133B854 was accomplished successfully in spite of the intricacies and close tolerances required of the part. For example, it has six different diameters in addition to a thin flange.

Manufacture of this part starts with preforms made by hot pressing titanium powder to maximum density. Optimum preform size is 2 in. o.d. x 0.8125 in. i.d. x 0.6875 in., and it weighs 130 gm. The preform, coated with a lubricant, is heated to 1000 F, and press formed in heated tool-steel dies at pressures up to 90 tsi.

To avoid die failure, the part is press formed in two operations. The first pressing forms a cup having a hole in the center of the bottom and the second produces the final shape. Parts made by this process are free machining and finishing cuts of 0.0002 in., at lathe speeds common to mild steel, are used.

Press formed bearing housings have passed 150 hr engine qualification tests of both GE and U.S.A.F. Some bearing housings have been run as long as 1500



***J73 jet engine** bearing housings produced from titanium powder.*

hr and no failures have been experienced.

Hot pressed parts

A hot pressing method developed by Clevite cuts costs for prototypes and for large titanium shapes by eliminating costly tool steel dies necessary even for small quantities of trial parts. Instead, the hot pressing process uses low cost graphite dies machined to the general contour of the part. Hot pressing produces maximum density titanium shapes with mechanical properties equivalent to those of wrought material. GE jet engine bearing housings made by hot pressing have operated successfully during engine endurance tests.

In the hot pressing process, titanium powder is heated under pressure to 1925 F for periods of one to four hours, depending upon the size and shape of the part. The combined pressing and sintering operation takes place inside a vacuum-tight alloy steel chamber at a gas pressure of less than 5 microns.

The development equipment is most suitable for the manufacturing of prototype parts. Volume production by hot pressing would require extensive equipment modification. However, the present equipment may compete with arc-melting processes in the manufacture of cylindrical billets weighing over fifty pounds because of the high utilization of the powder. Machining 0.020 in. from the surface produces a clean, dense billet at a selling price of $12 per lb.

Maximum density and excellent physical properties are obtained without difficulty in manufacturing protoype titanium bearing housings by hot pressing. Various accessory drive housings made by hot pressing titanium powder are illustrated. All of these housings were tested successfully on the J73 engine, the GE 9000 lb thrust class turbojet which powers the F-86H Sabre jet.

Hot pressing significantly reduced material utilization factors for all parts as shown in a table in which factors for hot pressing and forging are compared. For part O, hot-pressing reduced the material utilization factor from 12.30 to 1 to 3.20 to 1.

As prototype parts, hot pressed titanium bearing housings cost less than the same parts made by forging, in spite of the fact that forging dies were available. Lower cost of the hot pressed parts is a result of lower cost starting material and better material utilization.

For hot pressing the material was powder made from sponge while the material for forging was titanium bar. Titanium powder costs $7 per lb compared with $15 per lb for machined bar. In volume production it is estimated that the cost of converting sponge to powder will be fifty cents per lb. Use of hot pressed titanium parts also lowers machining costs because the preforms do not have the hard skin, resulting from diffusion of oxygen and nitrogen, common to the surfaces of forg-

MATERIAL UTILIZATION FACTORS FOR HOT PRESSED J73 BEARING HOUSINGS

Part	Calculated Finished Part Wt, lb	Hot Sintered Blank Weight, lb	Material Utilization Hot Sintered	Forging Blank Wt, lb	Material Utilization Forging
A	0.31	1.00	3.23	2.0	6.42
B	0.12	0.58	4.82	0.75	6.22
C	0.34	1.00	2.94	1.12	3.28
D	0.19	0.92	4.84	1.38	7.28
E	0.23	0.81	3.52	1.00	4.34
F	0.21	0.78	3.76	1.13	5.37
G	0.21	0.46	2.19	0.87	4.15
H	0.42	0.62	1.48	0.87	2.06
I	0.30	0.51	1.70	0.62	2.06
J	0.57	1.06	1.86	1.50	2.63
K	0.24	0.88	3.67	1.19	4.86
L	0.24	0.90	3.75	1.13	4.91
M	0.16	0.63	3.94	0.81	5.06
N	0.23	0.65	2.82	1.00	4.35
O	0.72	2.30	3.20	8.87	12.30
P	0.18	0.73	—	—	—

Note: Material Utilization $= \frac{\text{weight of raw material required}}{\text{weight of finished part}}$

PROPERTIES OF HOT PRESSED TITANIUM

Yield Str (0.2% offset), psi	40,000
Tensile Str, psi	58,000
Elongation, %	35
Reduction of Area, %	53
Rockwell Hardness No.	R_A 48
Impact Str (V-notch Charpy), ft-lb	
−318 F	32
−40	42
79	36
200	40
400	37

COST REDUCTIONS ON SEVERAL J73 BEARING HOUSINGS

Part	Unit Price Hot Pressed & Machined	Unit Price Forged & Machined Minimum
E	$62.00	$81.75
H	74.50	84.27
G	71.00	76.00
J	62.00	91.79
M	62.00	82.25

ings which wears cutting tools rapidly during initial, rough machining.

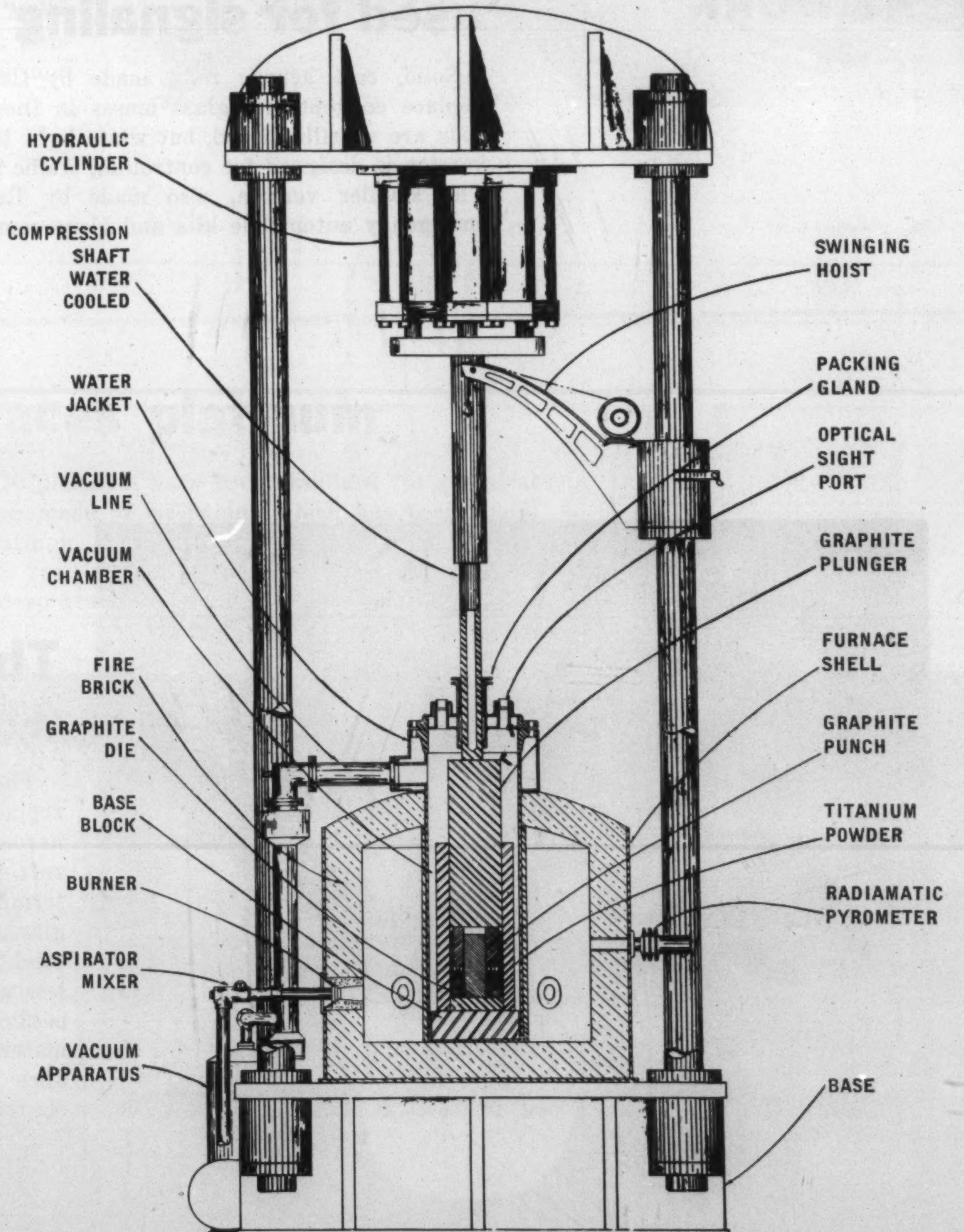
Data showing the cost reduction possible by using the hot pressing method on small lots are given in a table. Cost is compared with small production lots made by conventional forging practice. Cost quotations for the hot pressed housings are based on a production rate of sixty-five housings per month for a six month period. Cost of tooling for the hot pressed housing is $3000 for each design plus $18,000 for tooling applicable to all designs.

Since this study was made, forging costs have decreased by about one third and recent unit costs for forged and machined housings are about $10 less than the figures shown. Approximately the same percentages of cost reduction can be applied to hot pressed parts also. Material utilization factors markedly favor hot pressing. With increased volume, additional economies can be realized with additional cost reduction.

Acknowledgment

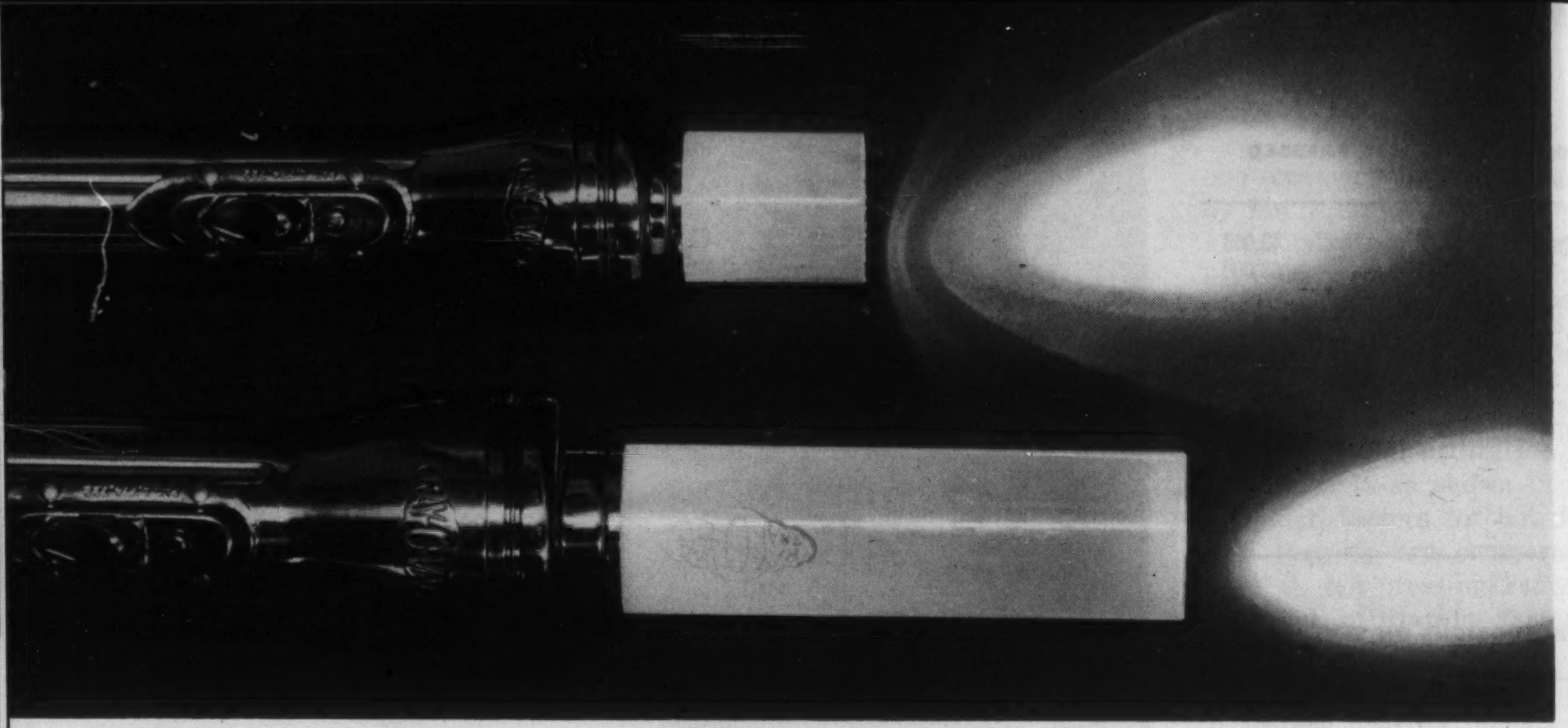
The author wishes to thank the Clevite Corp., particularly Harry W. Dodds, for the cooperation given in preparing this article.

Hot pressed *titanium bearing housings.*



HYDRAULIC CYLINDER
COMPRESSION SHAFT WATER COOLED
WATER JACKET
VACUUM LINE
VACUUM CHAMBER
FIRE BRICK
GRAPHITE DIE
BASE BLOCK
BURNER
ASPIRATOR MIXER
VACUUM APPARATUS
SWINGING HOIST
PACKING GLAND
OPTICAL SIGHT PORT
GRAPHITE PLUNGER
FURNACE SHELL
GRAPHITE PUNCH
TITANIUM POWDER
RADIAMATIC PYROMETER
BASE

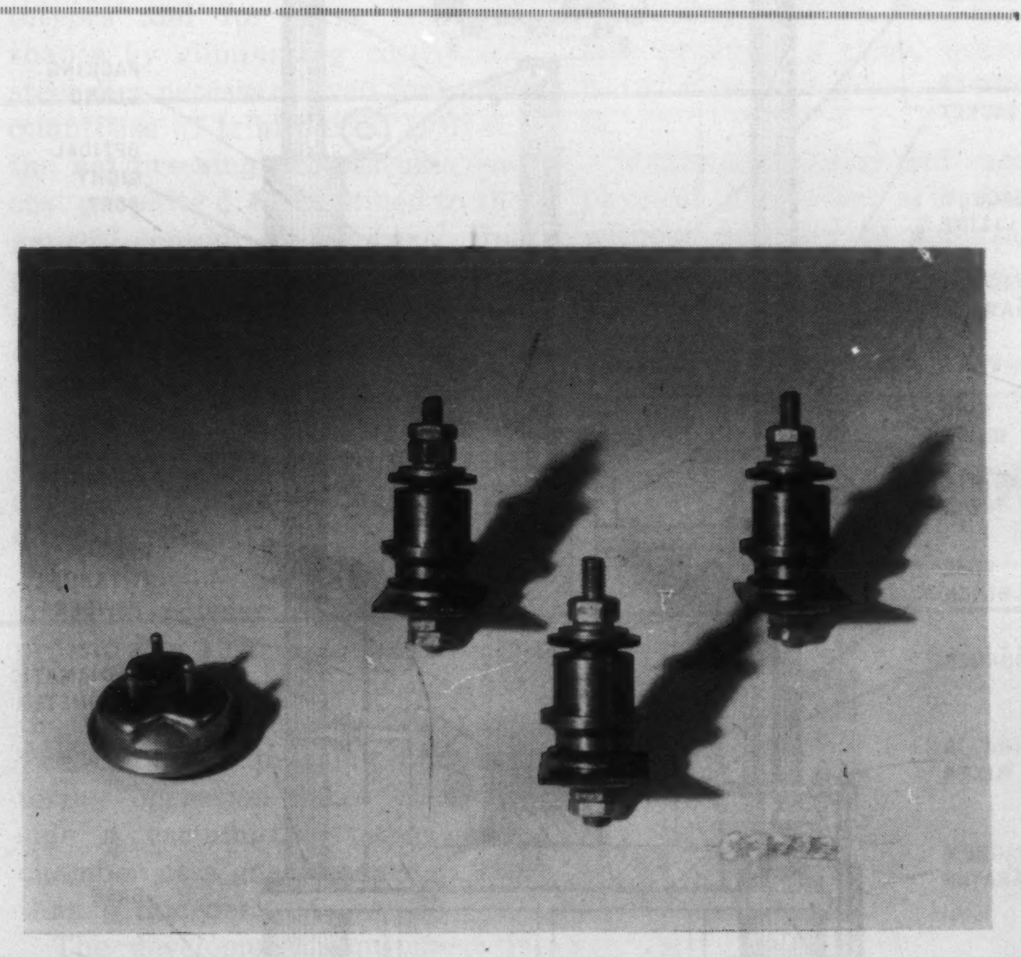
Hot pressing and sintering *occur simultaneously in this equipment.*



MATERIALS AT WORK

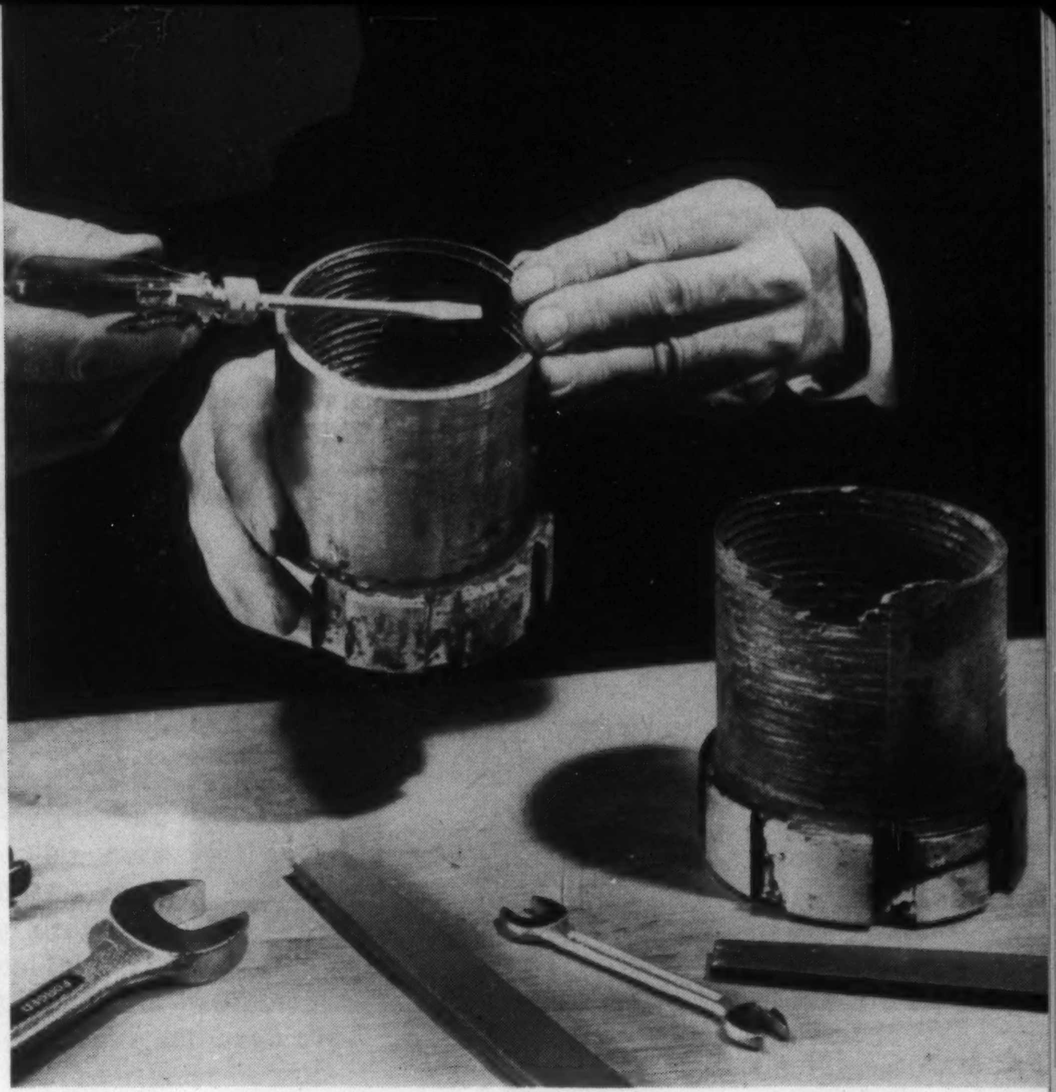
Red acrylic plastics used for signaling

Solid, cast acrylic rods, made by Cadillac Plastic & Chemical Co., replace conventional glass lenses in these flashlights. The sides of the rods are a brilliant red, but white light beams from the ends. The larger version is designed for controlling traffic in military and civilian airports. The smaller version, also made by Ray-O-Vac Co., is intended for emergency automobile kits and glove compartments.



Three to one with stainless

The small plug at the far left has replaced the three other fittings as hermetically sealed terminals for refrigerator compressors. The new terminal is made of cold rolled steel, glass and Type 446 Armco stainless steel wire. Advantages of the stainless wire are reported to be: 1) same coefficient of expansion as the other materials, 2) ample corrosion resistance without plating, 3) adequate electrical conductivity.

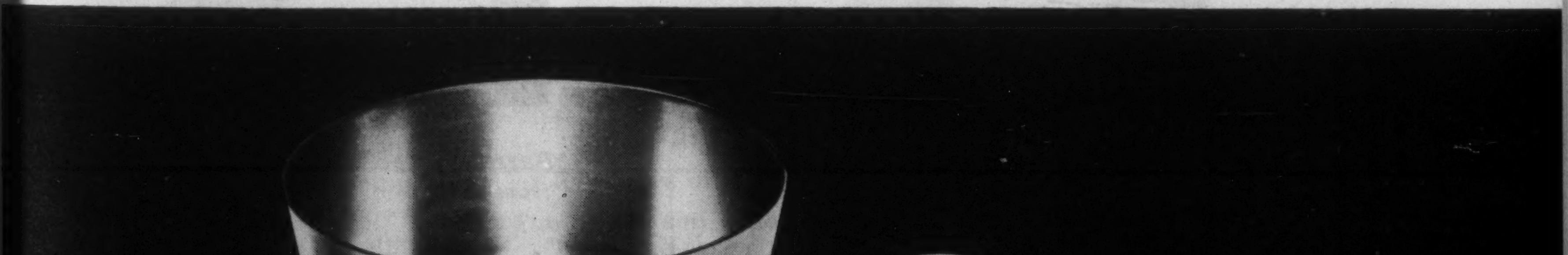


Moly disulfide adds service miles

Bushing at left has had 160,000 miles of service in a heavy duty truck trailer torsion suspension unit lubricated with a chassis grease containing 3% Moly-Sulfide additive, made by Climax Molybdenum Co. Duplicate bushing on right, which was lubricated with standard chassis grease, has score marks, broken threads and extensive wear after 35,000 miles. Difference is caused by Moly-Sulfide's adherence to metal surfaces, combined with its low coefficient of friction and low resistance to shear.

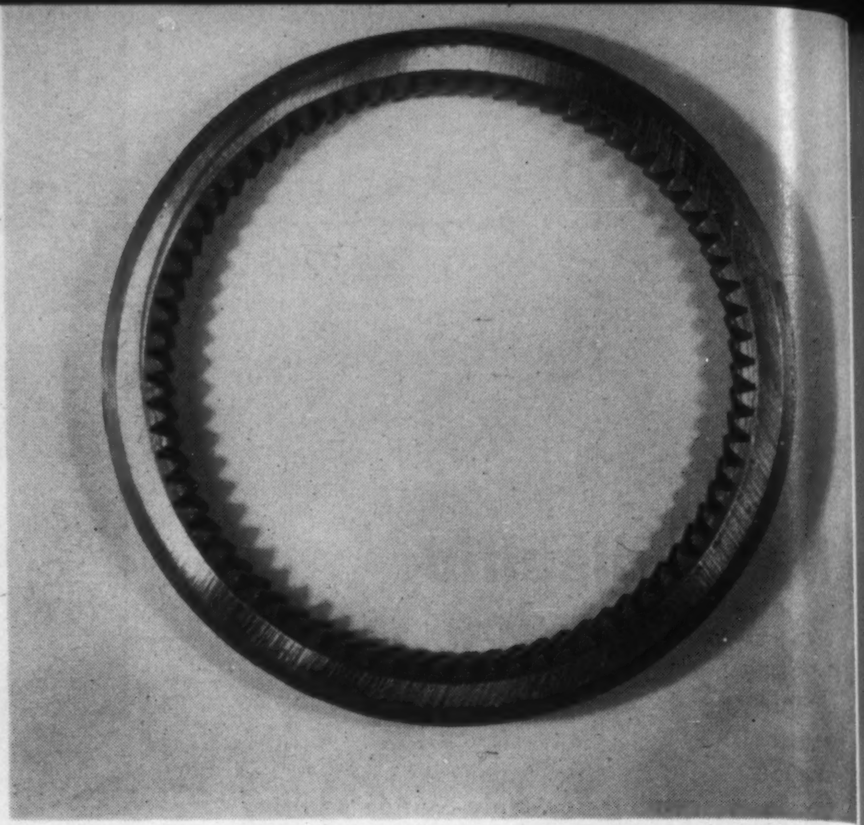
Zirconium replaces platinum

For years crucibles made of costly platinum have been standard for chemical laboratories. Now many are being made of zirconium, which has been found to give service comparable to platinum both in resistance to deterioration at high temperature and in chemical resistance. These zirconium crucibles, made by Brooks & Perkins, Inc., were deep drawn in a single stroke of press.



Rear axle housing *costs are reduced by use of tubing.*

Formed Steel Tube Institute

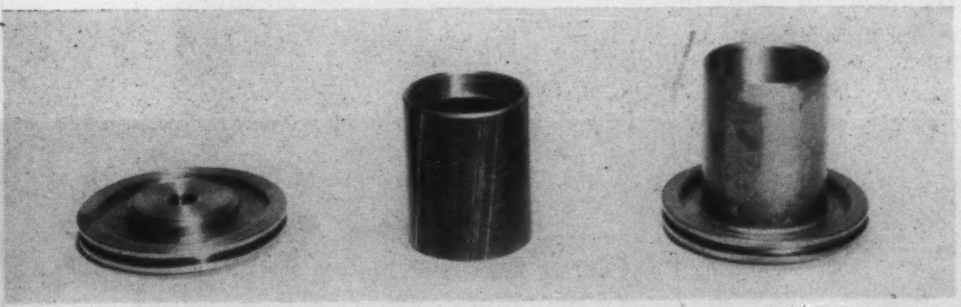


Detroit Transmission Div., G.M.C.

Ring gear *machined from tubing was produced at a cost reduction of 25% over the forging used previously.*

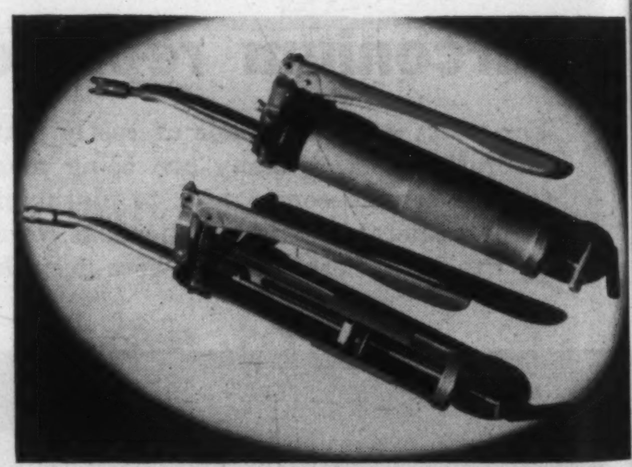
Mechanical Steel Tubing for Parts Fabrication

Cut-off tube sections can be machined, forged or cold formed to produce many parts at lower cost than possible with solid bar stock.



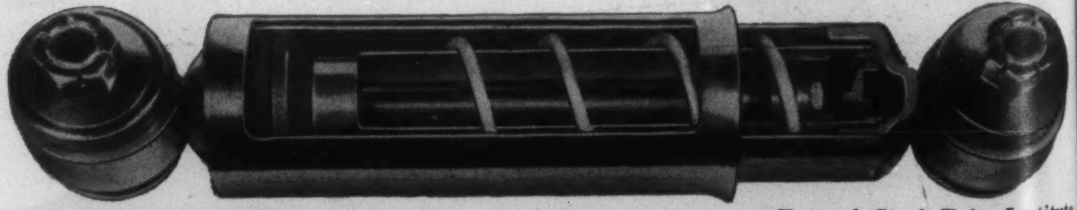
Detroit Transmission Div., G.M.C.

Piston *made by brazing a tubular section to a disk replaced a part made by machining from bar stock.*



Formed Steel Tube Institute

Barrels *of grease guns are readily produced from tubing.*



Formed Steel Tube Institute

Shock absorber *components can be formed from tubing with minimum machining operations.*

■ The advantages of mechanical tubing as the starting material for parts fabrication are being more and more widely recognized. This is evident from the gain in both the over-all tonnage of mechanical tubing sold, and in the increasing number of parts being made from it. For example, a manufacturer of tubing states that by the middle of 1954 his customers were making 26 different parts of tubing for automatic transmissions alone, and a year later 38 additional applications had been developed for the same mechanism.

Mechanical tubing is tubing made for some mechanical requirement or requirements rather than for use as a container for fluids or gases. Classified by application, it includes aircraft tubing, air-frame tubing, automotive tubing, bearing tubes, furniture tubing, precision pump tubes and structural tubing. However, applications of primary interest to the design engineer in the general manufacturing industries are those in which the tubing is machined, forged or cold formed to some shape in which its identity as a tube is lost. Cut off tube sections which are machined into gears for automatic transmissions are a typical application.

Types and sizes

Mechanical steel tubing can be produced in seamless, welded or centrifugally cast form. Seamless tubing is usually used if a hardenable grade is required.

Seamless tubing is produced by hot rolling, extruding, drawing, piercing and by combinations of these processes. Composition is one of the factors influencing the choice of process. High alloy compositions that would be difficult to roll hot are sometimes extruded and then reduced. Tubing of heavy wall thickness is usually seamless. Finish is improved by cold redraw. Dimensional accuracy of inside and outside diameters can be improved. Most tubing for applications involving machining is seamless.

Welded tubing is produced mostly in lighter wall thicknesses and usually has better concentricity than seamless tubing. In the lower carbon compositions, welded is usually somewhat lower in cost than seamless. Some medium carbon tubing is produced by welding, but much of its goes into applications outside the field of mechanical tubing.

Welded tubing is available with flash removed or with flash in. Cold redrawn stock is available where close tolerances or better finish are required. It is also produced with a ground finish on the outside surface.

For large diameters, centrifugally cast steel tubing is economical. Large diameters with light wall thicknesses can be produced by welding also.

Mechanical tubing is available in many compositions in both standard and special sizes, although the volume of the order must be sufficient to warrant the mill making up the special size. This makes it possible for the designer to specify the inside and outside diameter of tubing to meet his requirements most economically. The matter of composition is more difficult to adjust by special order, but steels of standard composition can usually be produced in tubular form.

Standard tubing is a close tolerance material. For 1 in. o.d. cold rolled steel tube, the tolerance will be about ±0.004 in. on the o.d. and ±0.005 in. on the i.d. For 2 in. cold rolled steel tube, the tolerance will be about ±0.005 in. on the o.d. and ±0.008 in. on the i.d. A cold redraw brings these tolerances down to ±0.003 in. Special tubing can be drawn to tolerances of ±0.001 in.

Tubing vs solid stock

On a price-per-pound basis, tubing is more expensive than bar stock. In small diameters with heavy wall thickness, it also may be more expensive per foot. The choice between solid stock and tubing for a given application is determined by comparing the cost of tubing to the cost of solid stock plus the cost of drilling or boring operations. While the selection must be made after study of all the factors in each case, some general considerations may be of value:

Inside diameter required—Screw machine contractors investigate the possibility of using tubing when the hole required in a given piece is more than 2 in. in dia. Tubing manufacturers state that, in plain carbon steels, tubing will ordinarily have no advantage over solid stock in sizes below 1½ in. o.d. In expensive alloys, however, there is probably no smallest size limitation. Use of stainless steel tube for hypodermic needles illustrates how small sizes can go.

Length of hole required—Boring or drilling a hole over 3 or 4 in. long is expensive and cost increases rapidly with the diameter of the hole.

Possibility of saving operations in the plant—If close tolerances or a high finish are not required in the piece, it is sometimes possible to use cold drawn tube with no forming operation other than cutting to length. Tube stock used for linked chain is typical. Even when some forming is required, as in production of the races and shells in a simplified ball bearing, tubing can save machining operations in the plant.

Applications

For some applications, mechanical tubing can be cut to length and used with little or no additional processing. Links in chain belting consist of formed side pieces connecting tubular end members, through which a pin may be inserted to join the links. The tubular members are sometimes made of alloy steel tubing, cut to length and heat treated.

A spaghetti press is another example of the use of mechanical tubing with little fabrication. Originally the press consisted of a sheet steel cylinder with an orifice plate at the bottom. The cylinder was not sufficiently rigid for durability and was replaced by a special casting. These castings were difficult to obtain in small lots. A second conversion resulted in the use of thin walled steel tubing, which was cut to the required length at a steel warehouse and required no additional processing.

A hollow wrist pin for a large diesel engine was originally made from bar stock. It was converted to a screw machine operation using SAE 4140 hot rolled steel tubings 3.495 in. o.d. by 1.805 in. i.d. Cost per pin made from tubing was about half that of the pin machined from solid stock.

Changing from bar stock to mechanical tubing eliminated drilling in producing vertical traction shaft for a power shovel. The shaft is made by cutting the tube to length and machining the outside diameter. Cost of the finished piece was reduced 25%.

Mack Mfg. Corp. formerly produced a hollow steel rear axle spindle for trucks from bar stock. Because the spindle length was too great to drill easily in one operation, their practice was to drill half-way through, reverse the bar and drill from the other end. Difficulty in aligning the two holes resulted in high scrap loss. To reduce costs, the company decided to use seamless tubing for the spindle. Hot rolled, tempered and descaled SAE 4140 tubing was selected. This tubing was cut to length, heat treated and straightened. Machining was required only on the outside. The conversion eliminated difficult drilling operations and reduced scrap loss.

A rear internal ring gear for automatic transmissions used to be made from steel forgings at Detroit Transmission Div. of General Motors. It was decided to switch to SAE 5140 steel tubing using stock 6.844 in. o.d. by 5.185 in. i.d. The tube is machined to size and cut off to form a blank. This blank is faced and internal teeth are broached. Teeth are deburred, the outside diameter is finish-turned, an external spline is wire brushed and the gear teeth are finish-shaved. The gear is then hardened and tempered, vapor blasted and the outside diameter ground to size. Savings of about 25% are reported.

RELATIVE PRICE OF COLD DRAWN LOW CARBON STEEL TUBING (BAR PRICE =100)

Wall Thickness, in.	Outside Dia, in.		
	2	4	6
solid	100	100	100
1	—	135	83
½	—	71	45
⅜	1252	—	—
¼	898	39	25
⅛	542	23	18
3/32	469	—	—

Rolls for crushing oats in a oat flaking machine were originally made of cast iron. These rolls tended to wear rapidly because of the abrasive action of the oat hulls and sometimes developed permanent deflection at operating loads. SAE 4150 steel tubing, 7¾ in. o.d. by 5⅝ in. i.d. was tried. The tubing was cut to length, machined to size, heat treated and finish ground. Inserting the heads and attached journals completed the fabrication. Resistance to deflection under load and to abrasion was improved.

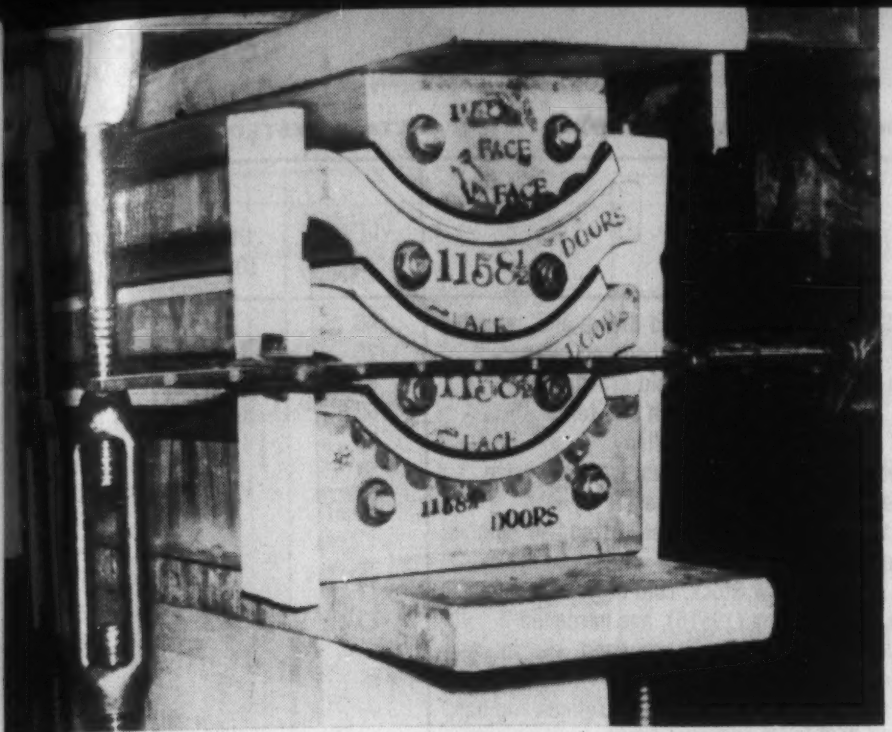
Thin walled mechanical steel tubing is widely used as a starting material for parts to be produced by bending or press forming. An example is an automobile steering jacket, produced from tubing by a series of press and machine operations. After cutting to length, one end of the tube is expanded and flanged and indentations are formed in the expanded portion. The inside diameter in this expanded portion is reamed to provide a bearing seat. Three holes are extruded and tapped, and finally a large T-slot is punched in the side of the expanded tube.

Mechanical tubing is used less widely as starting material for forging operations than for cold fabrication. Since some qualities of tubing, especially finish and dimensional accuracy, are lost in the forging procedures, there is little advantage to compensate for the higher cost of the tubing.

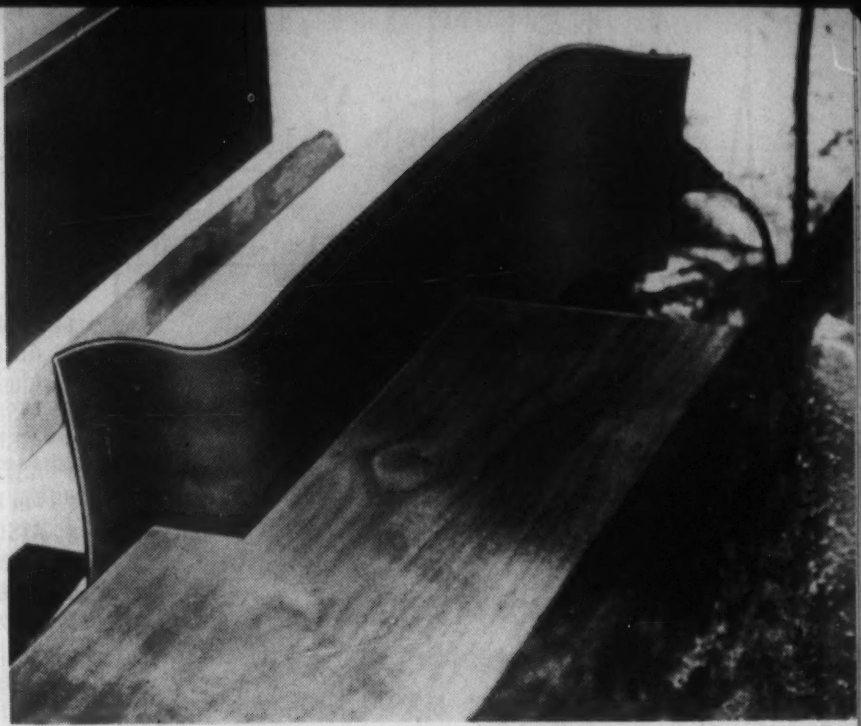
However, tubing is used for some applications involving limited hot working where the heating can be done by induction or other quick heating process. An example is a tubular push rod used in an automotive valve train. This push rod formerly made of 1/4 in. dia rod, was replaced by 5/16 in o.d. tubing. Tubing is fabricated by swaging the ends to produce hollow push rods with small axial holes in both ends. In addition to the weight saving and reduced inertia of the valve train, the hollow rod serves, in some cases, as a channel for supplying lubricating oil to the socket end of the rocker arm.

A piston rear accumulator consisting of a flange at one end of a hollow cylindrical section was formerly machined from bar stock. It was redesigned to be made in two pieces, a disk and a hollow tubular piece. The disk is machined from 2 7/16-in. bar stock of SAE 1113 composition on a screw machine. The tubular portion is machined from SAE 1118 steel, 1 13/32 in. o.d. and 1 3/16 in. i.d. Copper brazing the two together completes the piece with a minimum of wasted steel. This conversion saved about 40% in the material cost and resulted in an over-all saving of 20%.

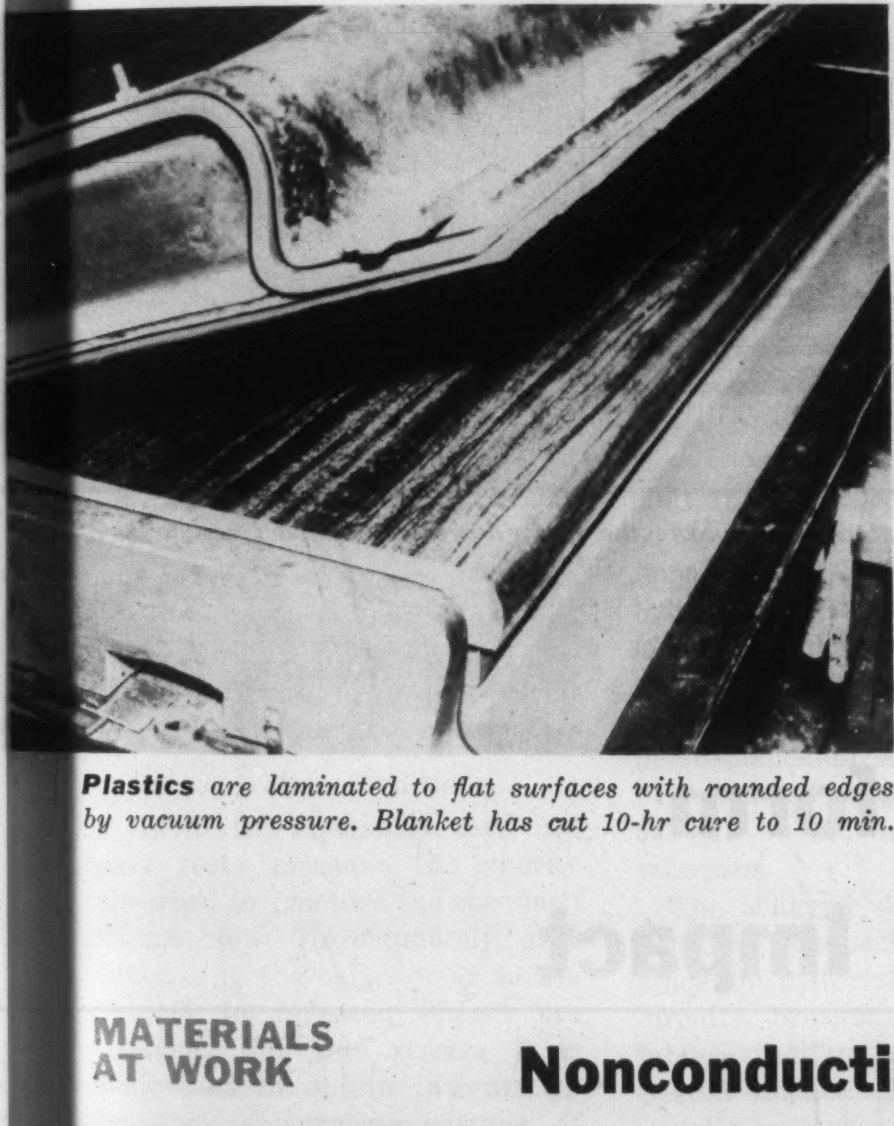
For applications requiring large diameter heavy wall tubing, centrifugally cast steel tube may serve. Such tubing is used in the drums of tire building machines for forming truck and other heavy duty tires. Although rubber tires for passenger cars are made in molds, those of larger size are handmade over a collapsible drum. The drum can be a casting or a weldment, but tire manufacturers are switching to drums made of centrifugally cast mild carbon steel tubing, 10 3/4 in. or 13 1/2 in o.d., with 1 1/2 in. wall. The tube is machined over the outside surface and cut into 3, 6 or 7 sections to permit collapsing and withdrawing the drum after the tire has been formed. Drums range from 8 to 18 or 20 in. in length. Use of cast steel tubing gives the tire manufacturers a material requiring little processing to complete fabrication into the drum.



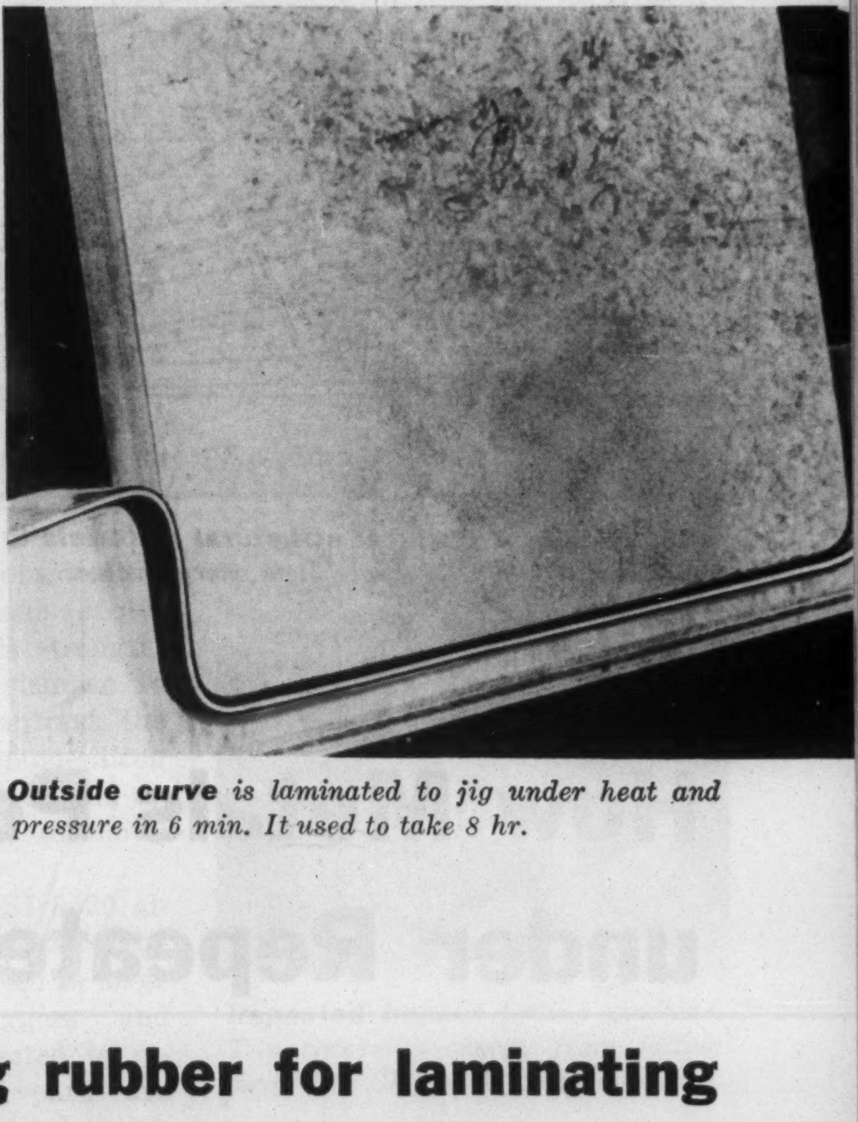
Glue lines *in plywood lay-up for chairbacks are cured under pressure. Blankets are between plywood and male mold.*



Blanket *is used for edge sealing a plastic surface to an inside curve. Lead to electrical source is at right.*



Plastics *are laminated to flat surfaces with rounded edges by vacuum pressure. Blanket has cut 10-hr cure to 10 min.*



Outside curve *is laminated to jig under heat and pressure in 6 min. It used to take 8 hr.*

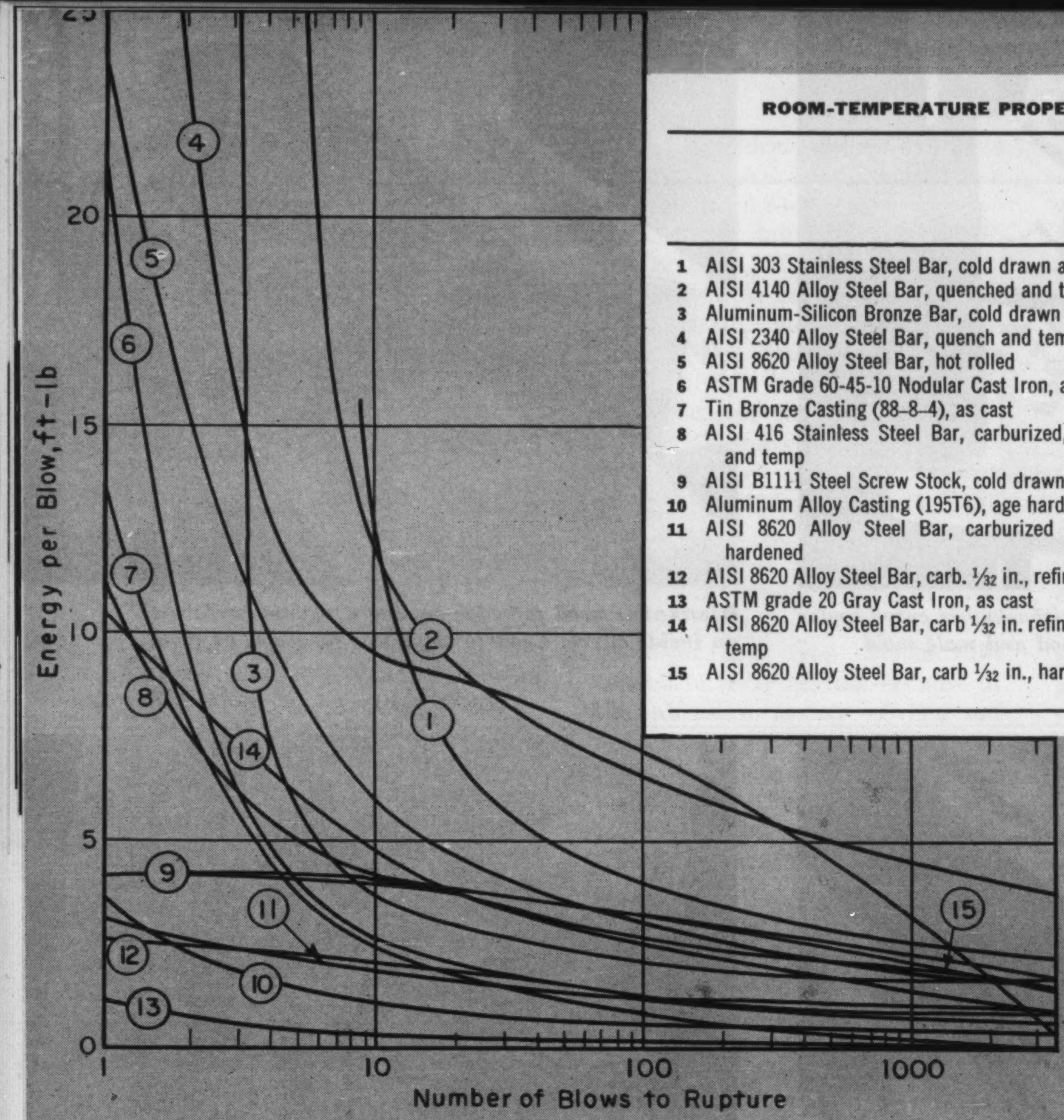
MATERIALS AT WORK

Nonconducting rubber for laminating

Electrical blankets made of thin rubber are heat curing glue lines, pre-heating plastics, liquefying solids and speeding up chemical reactions. Made by U. S. Rubber Co., they use a conductive rubber element instead of heating wires. The ⅛-in. blankets can be bent around corners, stuck into crevices or applied between surfaces and put under pressures to 200 psi. They can be glued to almost any surface and nailed or stapled along the edges.

Furniture manufacturers have found that the blankets save time and eliminate cumbersome apparatus. Elsewhere they are used to keep gas lines and valves free of ice and to liquefy tar.

The blankets have a sandwich-like construction. In the center is a paper-thin layer of rubber that conducts electricity instead of insulating it as rubber usually does. The layer is vulcanized between two sheets of nonconductive neoprene rubber. The conductive rubber is energized by a flat conductor that runs along only two parallel edges of the blanket under the neoprene cover.



ROOM-TEMPERATURE PROPERTIES OF METALS TESTED FOR RESISTA

		Yld Str, 1000 psi	Ult Str, 1000 psi	Elong, % in 2 in
1	AISI 303 Stainless Steel Bar, cold drawn and annealed	40	90	40
2	AISI 4140 Alloy Steel Bar, quenched and tempered	125	135	20
3	Aluminum-Silicon Bronze Bar, cold drawn	82.7	99.7	19.6
4	AISI 2340 Alloy Steel Bar, quench and temp	160.6	163.9	16.1
5	AISI 8620 Alloy Steel Bar, hot rolled	65	113	23
6	ASTM Grade 60-45-10 Nodular Cast Iron, annealed	50	68	18
7	Tin Bronze Casting (88–8–4), as cast	21	45	25
8	AISI 416 Stainless Steel Bar, carburized, air quench and temp	—	—	—
9	AISI B1111 Steel Screw Stock, cold drawn	77.5	83.3	20.1
10	Aluminum Alloy Casting (195T6), age hardened	29.2	36.3	1.9
11	AISI 8620 Alloy Steel Bar, carburized 1/32 in. and hardened	—	—	—
12	AISI 8620 Alloy Steel Bar, carb. 1/32 in., refined and hard	—	—	—
13	ASTM grade 20 Gray Cast Iron, as cast	—	22.5	—
14	AISI 8620 Alloy Steel Bar, carb 1/32 in. refined, hard and temp	—	—	—
15	AISI 8620 Alloy Steel Bar, carb 1/32 in., hard and temp	—	—	—

Behavior of 15 typical structural materials *to repeated impact. Note the sharp decrease in impact resistance of materials with high single blow energy values.*

How Metals Perform under Repeated Impact

Here is much needed information on how different metals stand up under conditions of repeated impact. Comparative ratings are given for a number of wrought and cast materials, both ferrous and nonferrous.

by E. L. Layland, *Materials Engineering Dept., Westinghouse Electric Corp.*

■ Together with hardness and tensile testing, impact testing is one of the most frequently used testing methods for determining the mechanical properties of metals. Although impact data are difficult to correlate with the actual service performance of engineering structures, the test at least rates materials in the order of their ability to absorb impact loading *nce of*

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RESISTAN TO REPEATED IMPACT

Elong, % in 2 in.	Red. in Area, %	Brinell Hardness	Single Blow Charpy Impact Str, ft-lb
40	59	170	—
20	60	270	73
19.6	70.7	187	85
16.1	57.4	363	43
23	60	228	24
18	18	150	21
25	30	76	13
—	—	600	11
20.1	59.5	170	4
1.9	5.8	93	3.5
—	—	700	3
—	—	700	2.5
—	—	170	1
—	—	630	10.5
—	—	630	4.5

Testing Machine and Procedure

A new testing machine, which is shown in the accompanying photograph, has proved quite successful in determining the resistance of structural materials to repeated impact. Specimens are the Charpy V-notch type, 0.394 x 0.394 x 2.165 in., and contain a 0.079 in. deep, 45 deg notch on one side. Each specimen is supported as a simple beam with the notch on the tension (bottom) side. Frequency of the blows is approximately 8 per min.

During each test run the weight of the hammer and its end velocity are adjusted so as to maintain the same energy input value to the specimen at each blow until rupture occurs. The test is repeated with identical test specimens at different energy input values. Overall impact resistance characteristics are then determined by plotting the energy per blow versus the number of blows to rupture.

All of the materials tested showed some permanent set with the first blow at all of the energy levels investigated. In most structures a permanent set of the materials denotes failure. However, since an excessively long testing time would be required to cause failure of a specimen without plastic deformation, this line of investigation (which would resemble a fatigue test) has not been pursued.

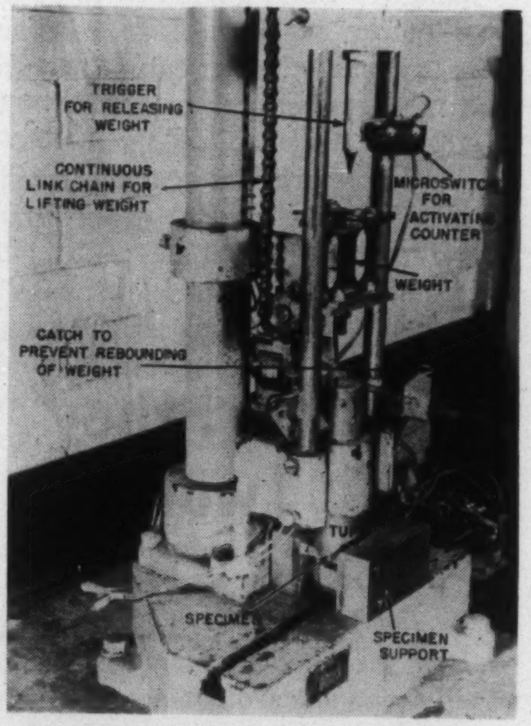
under controlled conditions.

All of the commonly used impact tests measure the energy absorbed to fracture the specimen in one blow. Unfortunately, data concerning the behavior of metals subject to repeated impact are meager. For this reason, it is important to obtain information on the comparative ratings of wrought and cast ferrous and nonferrous metals and to determine the relationship between the energy of impact and the number of blows to rupture a specimen.

Repeated impact tests involving 15 major structural materials (see table) show that for most materials the energy per blow decreases rapidly as the number of blows increases. As shown in the graph the materials with the highest single blow energy values show the most rapid decrease.

Of the materials tested, alloy steels AISI 4140 and AISI 2340, heat treated to 270 and 363 Brinell hardness respectively, exhibited the best resistance to repeated impact. AISI B1111, considered a brittle steel on the basis of its low single blow impact strength, also exhibits good resistance to repeated impact. In contrast, the performance of aluminum-silicon bronze does not appear to hold up as well as the number of blows increases.

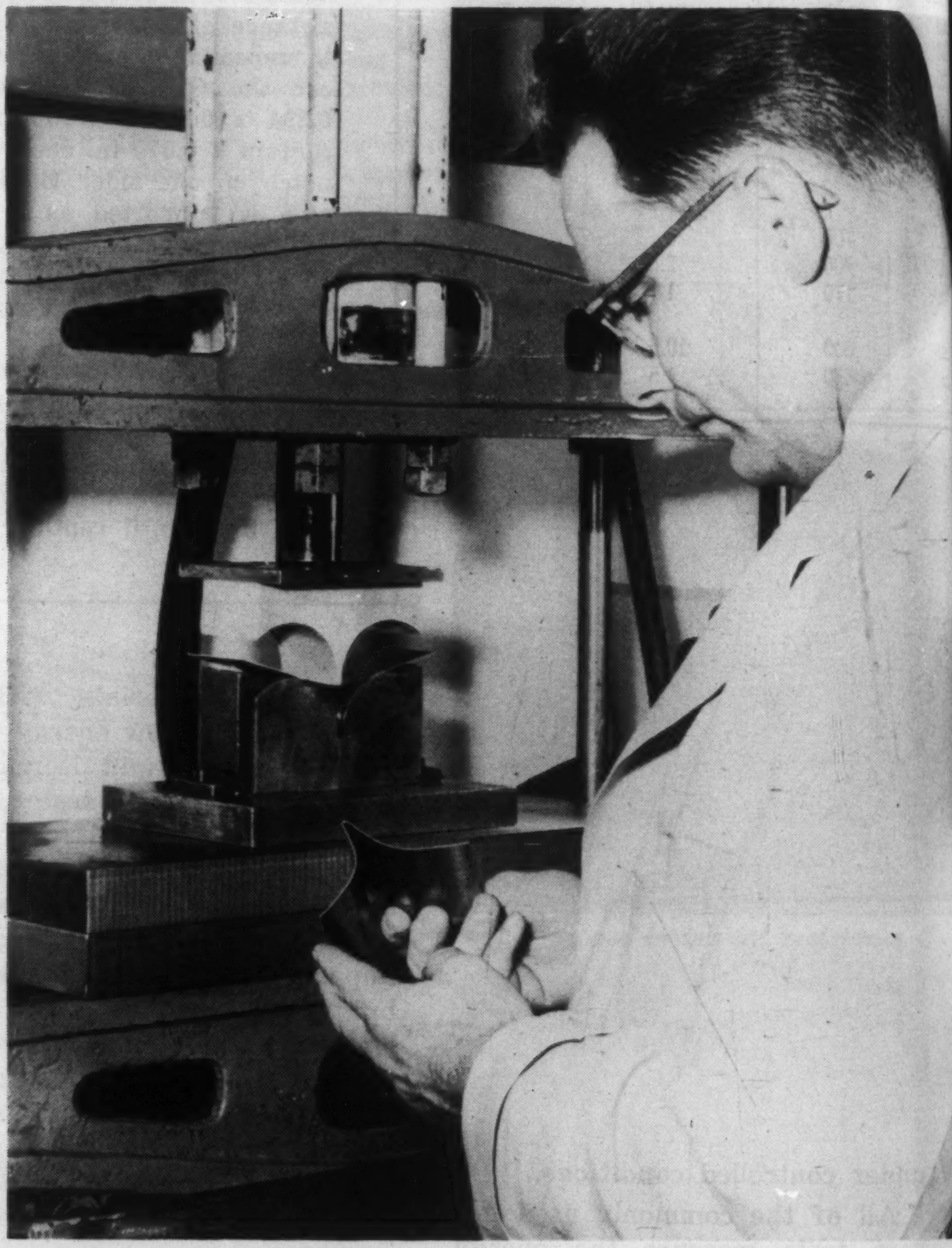
The behavior of AISI 8620 alloy steel is especially noteworthy since this material is used in large circuit breaker triggers and latches that are subjected to repeated impact. These parts are usually carburized, refined, hardened and then tempered to produce a hard, wear resistant case that must withstand high unit loads and a soft, tough core with high shock resistance. For test purposes, this standard heat treatment was modified by eliminating the refining and tempering operations. Tests reveal that beyond ten blows, unrefined specimens perform better than those that have been refined. Tempering improved both groups. It should be noted that although case hardened AISI 8620 is only fourth or fifth in its ability to withstand more than ten blows, it deforms almost negligibly in comparison with materials of higher impact resistance.


TRIGGER FOR RELEASING WEIGHT
CONTINUOUS LINK CHAIN FOR LIFTING WEIGHT
MICROSWITC FOR ACTIVATI COUNTER
WEIGHT
CATCH TO PREVENT REBOUNDING OF WEIGHT
TU
SPECIME
SPECIMEN SUPPORT

Repeated impact *testing machine. Tup transmits energy from falling weight to Charpy V-notch specimen.*

Polyamide-Epoxy Resin Blends for Tooling

. . . . they worked here



For short run production *glass fiber and filler reinforcement provide sufficient strength in the thin shoulder of a polyamide-epoxy punch.*

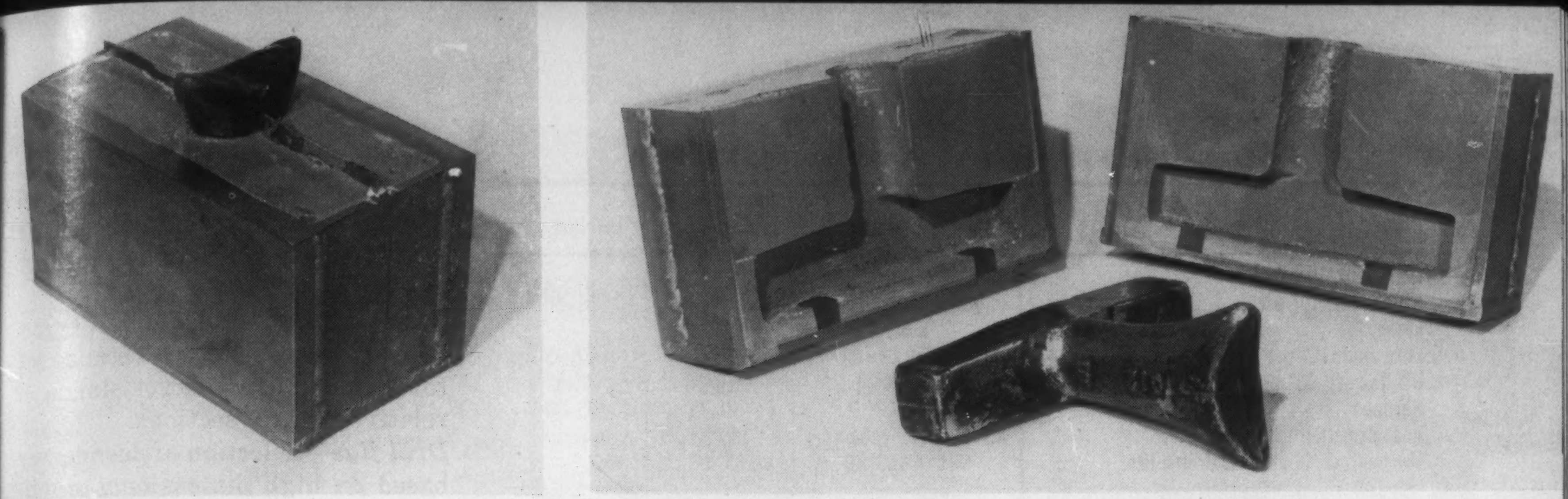
Two big advantages of these new combinations are:

1. *Eliminate need for toxic curing agents.*
2. *Have higher impact resistance.*

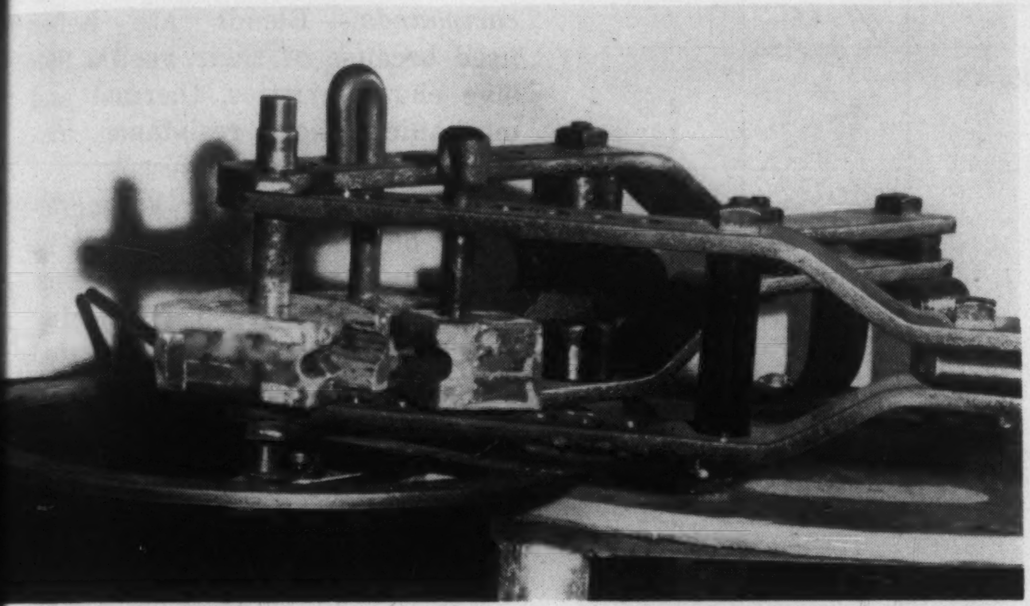
by D. E. Peerman, *General Mills, Inc.*

■ The unique characteristics of epoxies have already assured them a predominant position as a tool material for models, dies, jigs and fixtures. Now, by combining them with new polyamide resins, new materials have resulted which retain most of the desirable features of epoxies while minimizing their disadvantages.

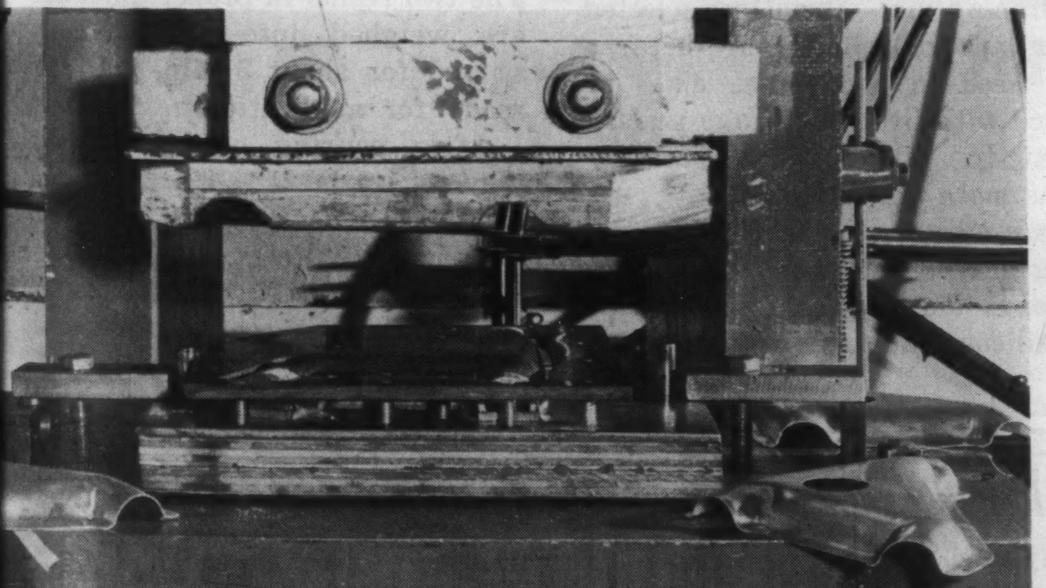
The new polyamide resins, called Versamids, are based on vegetable



Vise jaw *made of the new material simplifies holding problems during machining of this odd shaped part.*



Tubing formers *can be fabricated inexpensively with polyamide-epoxy blend, speeding quick change from one size stock to another.*



Aluminum parts *are produced more economically by Champion Aircraft Corp. on this polyamide-epoxy forming die.*

dimers and are country cousins of the well known polyamide, nylon. By mixing similar parts of Versamids with epoxy resins, the Versamid cures the epoxy, eliminating the need for toxic amine curing agents. Also, resilience of the polyamide improves impact strength of the epoxy, though at some sacrifice in modulus.

An additional processing advantage is the reduction in exothermic heat generated during cure, allowing thicker sections to be cast or laid up in one operation. In straight amine-cured epoxy systems, exothermic heat must be carefully controlled either with fillers or by curing relatively small volumes at a time, in order to prevent blowing or charring of the casting or laminate.

If flexible or semi-flexible thermosetting materials are desired, as in facings of drop hammer dies, a larger amount of Versamid is used in relation to epoxy. The resulting tough, extensible product does not change with aging and the resilient facings resist tearing and flow under working conditions.

The blends can be used either as casting resins or with glass or other reinforcing materials in laminates. They have low shrinkage, excellent adhesion to a variety of materials, excellent wetting and adhesion characteristics to glass fibers, high strength and dimensional stability and good machinability. Typical range of properties of the blends are shown in an accompanying table.

Applications

Tooling applications in which the materials have been successfully used include the following. *Master models* — Versamid-epoxy blends were used because they could be poured in large sections without excessive exotherm. Since

TYPICAL PROPERTY RANGE OF VERSAMID-EPOXY BLENDS

Property	Test Method	Castings	Laminates [a]
Comp yld, 10^3 psi	ASTM D695-52T	6.6-12	—
Ult ten str, 10^3 psi	ASTM D638-52T	5.3-8.6	31-50
Elong, %	“	7.0-9.3	—
Flex mod, 10^5 psi	ASTM D790-49T	1.4-3.0	17-25
Ult flex str, 10^3 psi	“	8.2-15.2	48-62
Hardness	Barcol	50-75	75-95
Heat distortion, F	ASTM D648 (264 psi)	105-185[b]	300+
Mechanical shock (3 ft drop), lb[c]	MIL-I-16923B	0.63-9.4	
Moisture vapor perm, 10^{-6} gm/hr/cm	“	0.48-0.90	
Moisture absorp, %	“	0.49-0.95	
Flammability, in./min	“	0.95-1.29	
Heat resistance, gm	“	−1.4 to 0.020	
Coef of therm expan, (to 266 F) 10^{-5} in./in./F	“	2.5-6.8	
Dielectric constant:	ASTM D150-47T		
73 F, 60 cycles		3.2	4.39
73 F, 1 mc		2.8	4.21
Power factor:	“		
73 F, 1000 cycles		0.025	—
73 F, 1 mc		0.015	0.013
Dielectric str (short time), 73 F, 60 cycles, v/mil	ASTM D149-44	2000	2000
Insulation resist, (Conditioned 96 hr, at 95 F, 90% RH), ohms	ASTM D257-52T	10^{12} to 10^{14}	1.45×10^{11}
Arc resistance, sec	ASTM D495-48T	80	135-140

[a] Laminates are 60-65% glass (6 ply 181 Fiberglas cloth, 0.060 in. thick).

[b] Heat distortion points given are for formulations recommended for maximum hardness. Formulation can be altered to provide ASTM heat distortion temperatures up to 220 F.

[c] Weight of steel ball causing failure.

much handwork was involved low toxicity was definitely advantageous. The dimensional stability, accuracy due to low shrinkage, and ease of machining were also determining factors in selection.

Draw Dies—High impact resistance, together with ease of casting in large sections and high physicals of glass-reinforced laminates indicated selection of the blends.

Checking fixtures—Lack of toxicity, low shrinkage and high dimensional stability caused selection of the blends.

Spinning dies—Blend was selected for a large spinning die because of need to pour large mass at once with little shrinkage and no toxicity. Dimensional stability was more than adequate.

Drop hammer die facing—By using altered ratio of Versamid-to-epoxy, die facings of sufficient resilience and toughness were produced. Facings did not break in applications where amine-cured epoxies modified with polysulfides had failed due to lack of stability on aging.

Stretch dies—Polyamide epoxy blends were selected because of toughness and wear resistance in relatively thin sections.

Drill jigs—Selection of blends was based on high dimensional stability and high adhesion characteristics that held bushings firmly in place to high degree of accuracy.

Putty, plastics solders and fairing compounds — Blends are being used because of their good adhesive characteristics, thermal and mechanical shock resistance, machinability and toughness.

On the other hand, Versamid-epoxy blends obviously cannot be used in all tooling applications. Such uses as dies for forming acrylic plastics where elevated temperatures are encountered are impractical due to the relatively low heat distortion temperature of the blends.

Blending and cure

The polyamide and epoxy resins can be blended in commercial paint shakers, in a proportionating mixing type of pump, or by hand mixing for smaller batches. The two resins in proper amounts are weighed into a container, stirred for about 3 min, and are ready for application.

After pouring or laminating, they set up in 2 to 4 hr at room temperature, or they may be cured for about 10 min at 300 F, or for 30 min at 200 F, or for longer periods at lower temperatures.

Epoxies suitable for combining with Versamids for tooling applications include Bakelite's ERL 2795, ERL 2774, or ERL 3793; Ciba's Araldite 502 or 6010; or Shell Chemical's Epon 828 or 815. Recommended ratios (parts by weight) of Versamid 125 to epoxy are as follows:

2 Versamid to 3 ERL 2795
3 Versamid to 7 Araldite 502
35 Versamid to 65 Epon 815

Note: For comprehensive information on plastics tooling, see two-part article, M&M, Dec '54, p 106, and Jan '55, p 89.

For further information on Versamid polyamide materials see M&M, Mar '56, p 150.

Curing Epoxies with Polyamides

The effect achieved by curing epoxies with polyamides can be explained by using a chain to represent the epoxy and the polyamide molecules. In the case of the epoxy the chain might have a length of 350-400 links, whereas the polyamide might have a chain length of approximately 1000-2000 links. Most common aliphatic or aromatic poly- and diamines would have a chain length of between 50 and 200 links.

When the longer chain reactive polyamides are cross-linked with the epoxy resins, a more flexible, resilient structure is obtained than that of the epoxy cross-linked with the shorter, more rigid molecules of the amine hardeners.

MATERIALS AT WORK

Vinyl-aluminum laminates cut weight on Train X

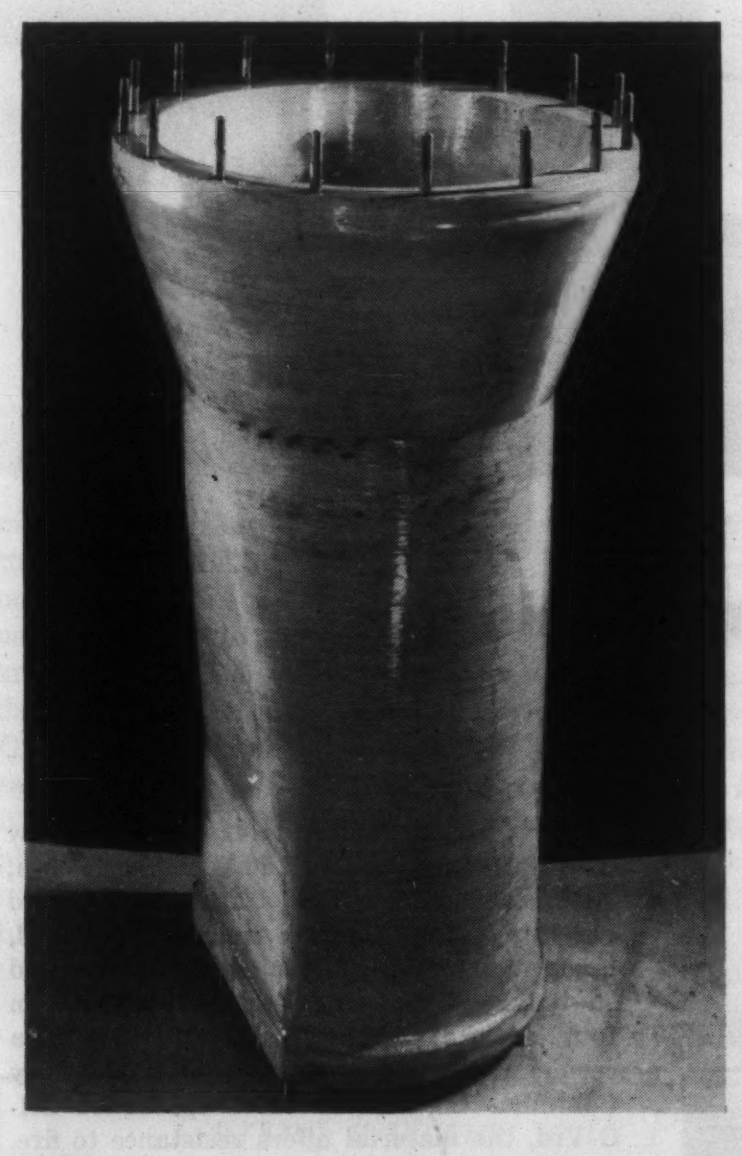
NEW YORK CENTRAL
X

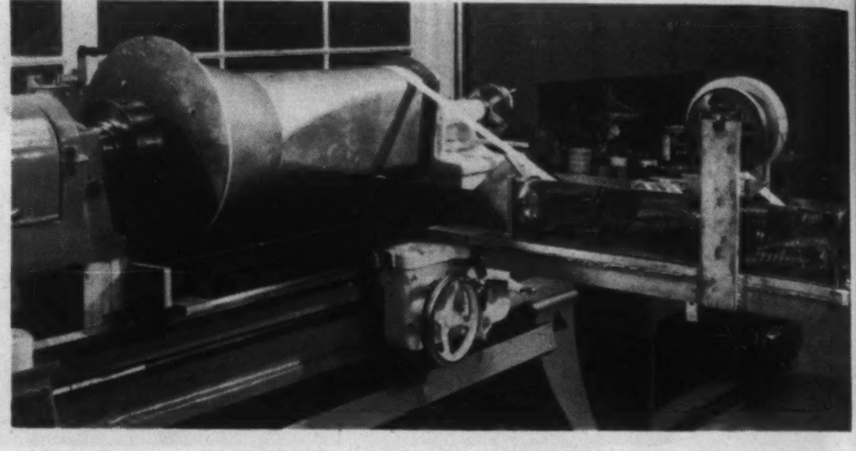
In building the Xplorer for the New York Central Cleveland-Cincinnati run, Pullman-Standard Car Mfg. Co. specified vinyl to reduce interior weight. The vinyl, laminated to lightweight aluminum, is used on bulkhead and partition installations. In four of the car interiors the vinyl is a cerulean blue Munster design made by Columbus Coated Fabrics Corp. Called Col-O-Vin, the material offers resistance to fire, scuffing and abrasion.

How Synthetic Resins Solved

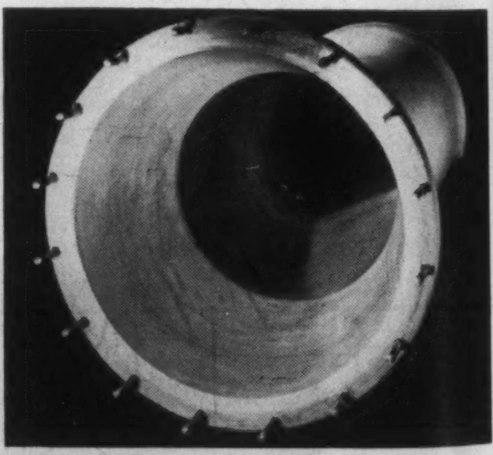
Where only a few parts are needed or where special design or electrical requirements must be met, the impregnating, laminating and coating techniques possible with plastics resins can often be used to advantage. The design and construction of high quality vacuum equipment, magnets and coils for nuclear research offer a good example of how previously difficult and tedious problems were solved by making use of polyester and epoxy resins.

by William W. Salsig, Jr., *Radiation Laboratory, University of California*





Aluminum mandrel used in forming vacuum pipe was covered with cellophane and wrapped with 2-in wide unsized cotton saturated with plastic. Mandrel is smeared with polyester syrup. Hand pressure over the point of contact plus tape tension forces the liquid on the mandrel up through the weave of the tape. A ¾ in. wall built up in approximately 12 hr.

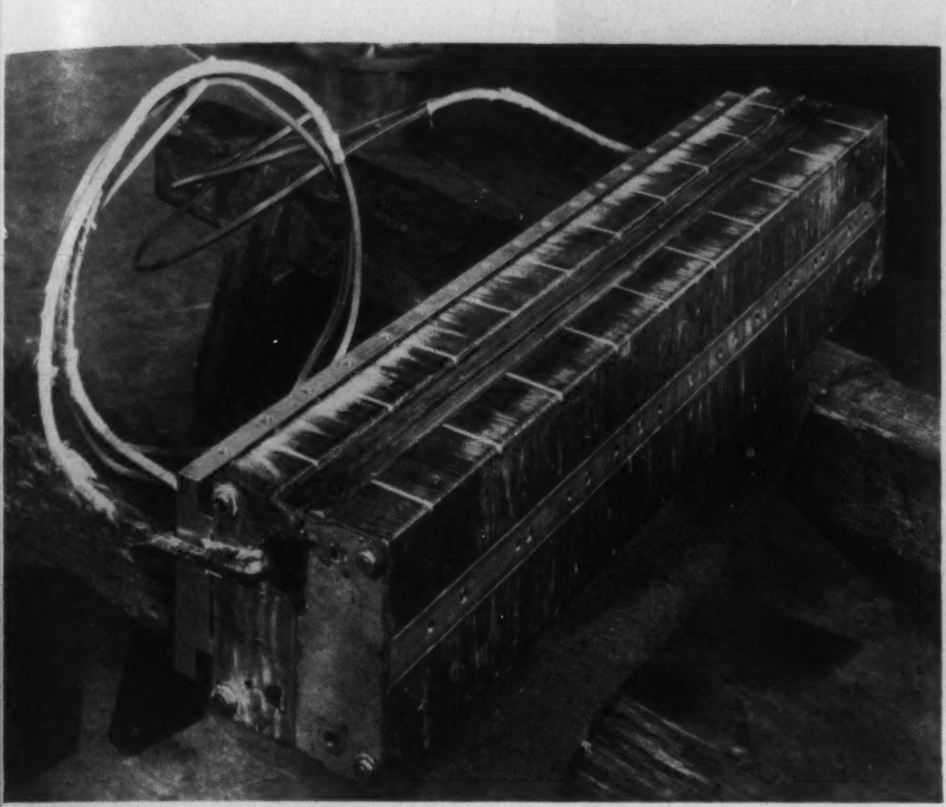


Pipe was cured on the mandrel and the mandrel withdrawn. After machining stud holes were tapped and the ends and outside of the pipe were painted with polyester syrup. Studs were installed in holes wet with syrup and the part cured again. Method produces a dirt resistant glaze seal and also provides an adequate gasket surface at the ends.

1. Vacuum Pipe

Some of the principal requirements of the materials used for vacuum pipe walls are that they must be electrically nonconducting, have a low atomic number, and possess good strength and impact properties. The following photographs show a vacuum pipe, 18 in. dia., of unusual configuration, for use at pressures of the order of 10^{-3} mm Hg. It was fabricated from cotton tape and polyester resin.

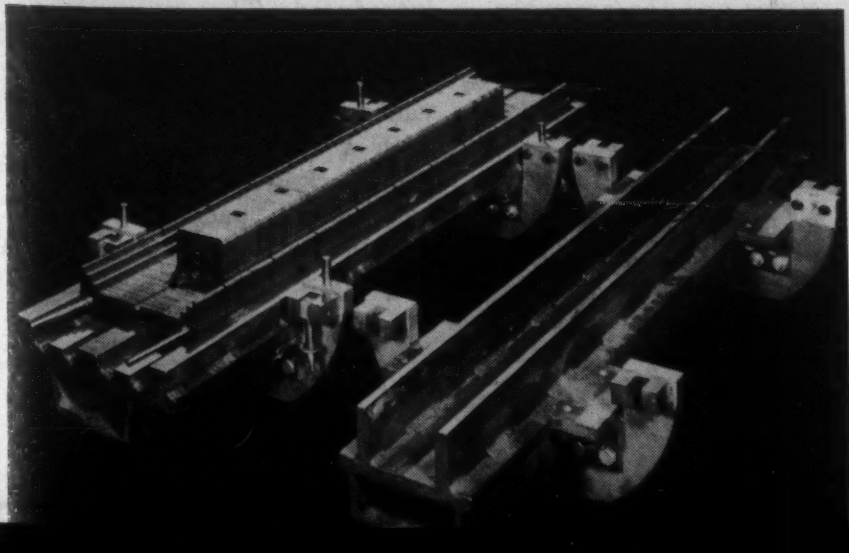
Four Special Design Problems

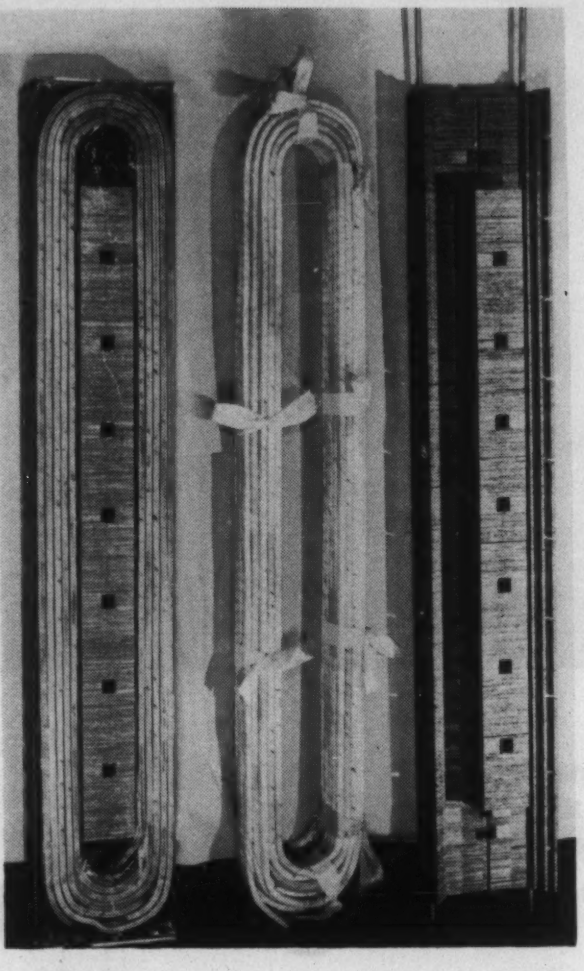


2. Electromagnetic Motor

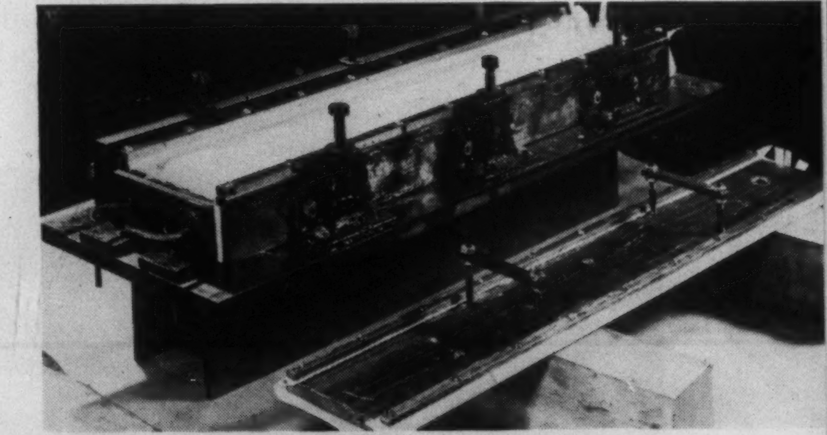
Design requirements for an electromagnetic motor that drives the moving element of a vibrating blade condenser include: a) ability to withstand vibration, b) good insulation between steel laminations, c) adequate electrical insulation of exciting coil, d) good mechanical and thermal bond between water-cooled coil and core, e) operation in high vacuum, 10^{-6} mm Hg, and f) maintenance of close tolerances at the blade face. The versatile properties of epoxy resin were utilized in this design application.

Steel laminations, 0.015 in. thick, were sprayed with epoxy resin and baked. Laminations were next dipped in epoxy syrup and stacked on the above fixture. During early stages of cure, the fixture was periodically removed from the oven, the bolts taken up until the final gage point lengthwise was reached. Continued baking produced a unit core with laminations flush to 0.003 in.

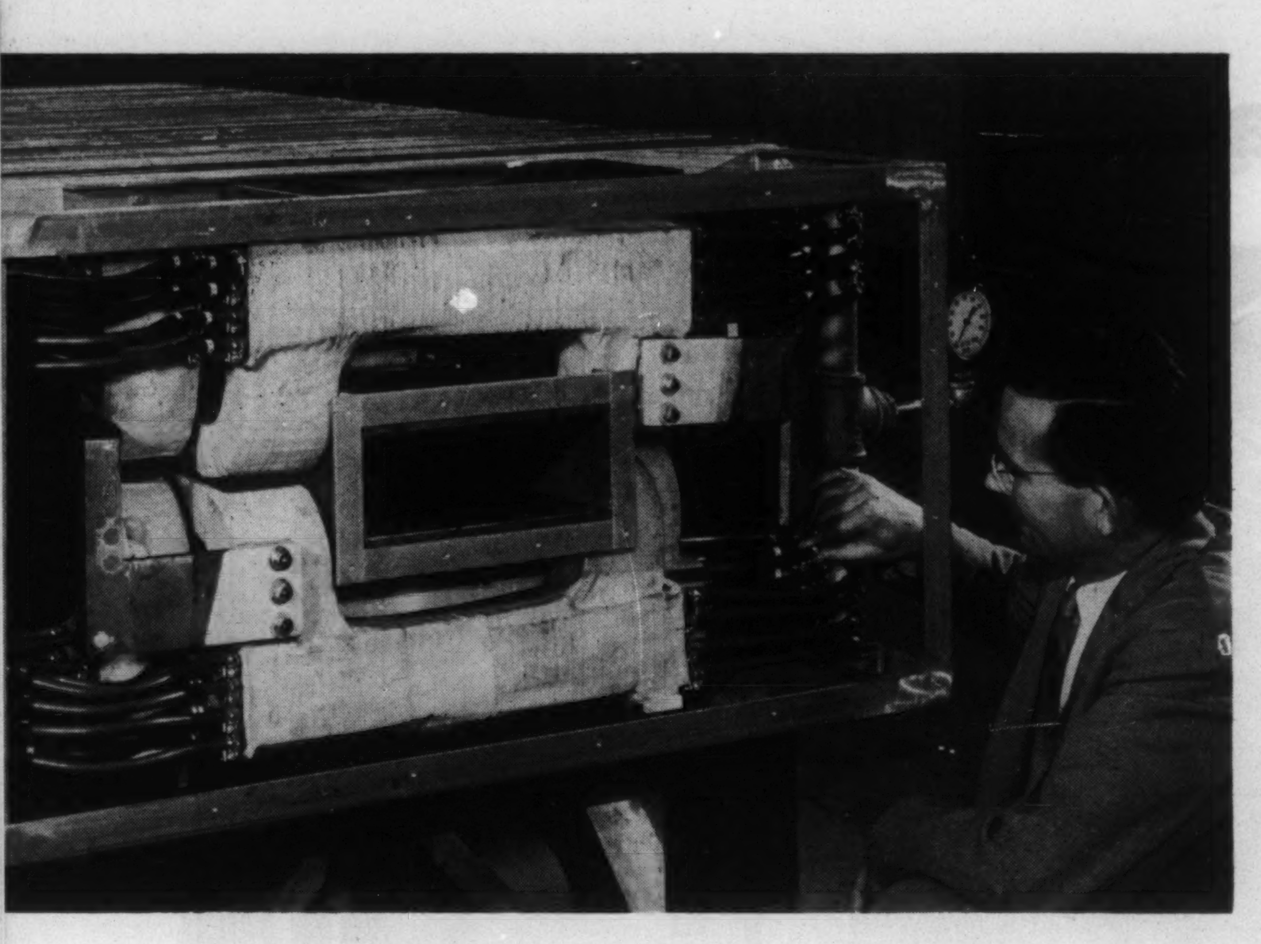




Conductor (center) was insulated by first coating with Formvar, next wrapping, ¾ lap, with 0.001 x 1 in. Mylar tape, and then spacing the taped conductor with fish paper 2 in. long by 0.015 in. thick, alternately placed vertically and horizontally.

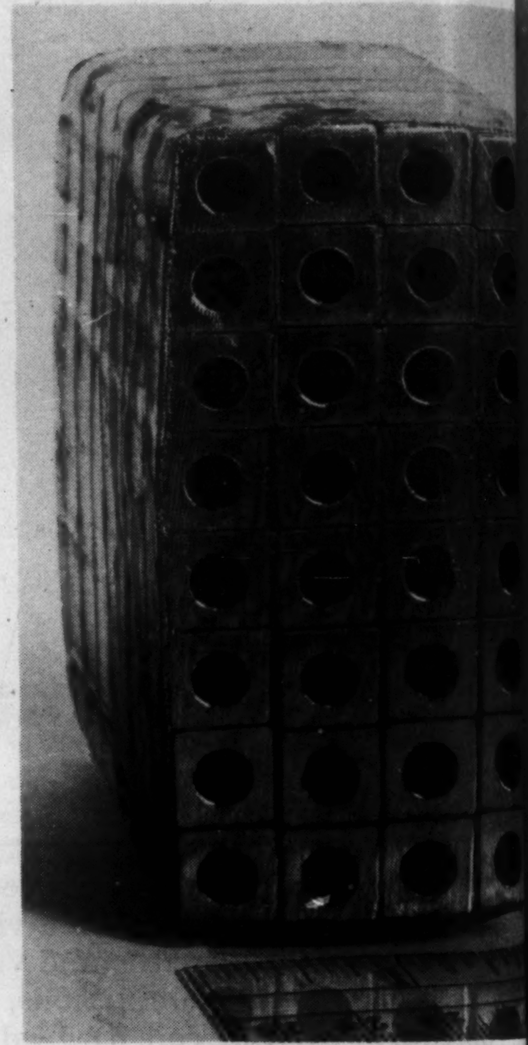


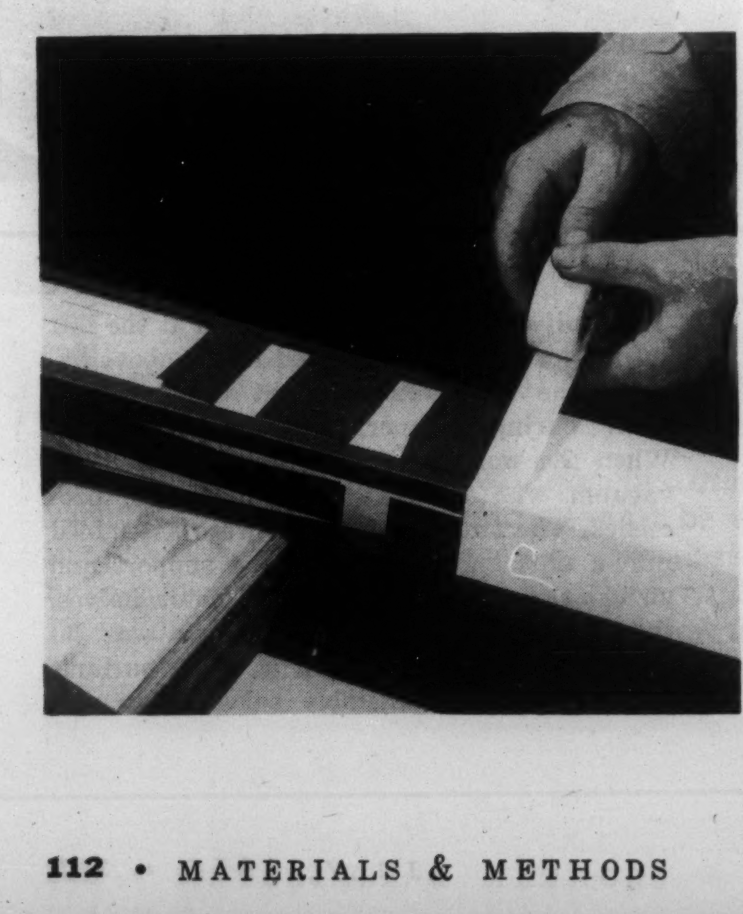
The coil-core subassembly shown at the left in previous photo was potted in the above fixture. The work was brought to the epoxy resin curing temperature under vacuum. When the work filled with liquid plastic, the vacuum was released and the curing proceeded. The two motor halves were assembled into a unit and, to obtain good support and no clearance between the two motor halves, the parting line was taped, plastic was injected into the gap with a veterinarian's syringe, and the assembly baked again.



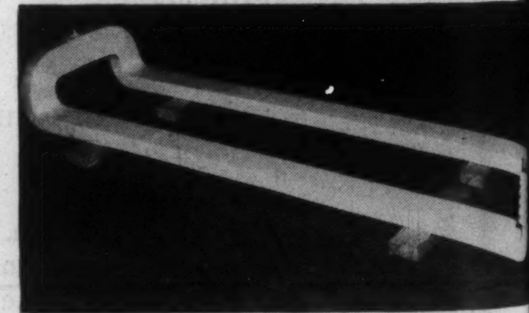
3. Bevatron Magnet Coil

A unique method of impregnating, suited to single component fabrication, was developed for the coils employed on a high intensity auxiliary magnet used with the UCRL Bevatron. This magnet provides a 22,000-gauss uniform field in a 4-in. gap over a 12 x 60 in. steel area, using 425 kw dc (1850 amp, 230 v) exciting powder. To provide flexibility (wider fields at lower intensities) the coils were made in four units, so the inner coils may be removed.

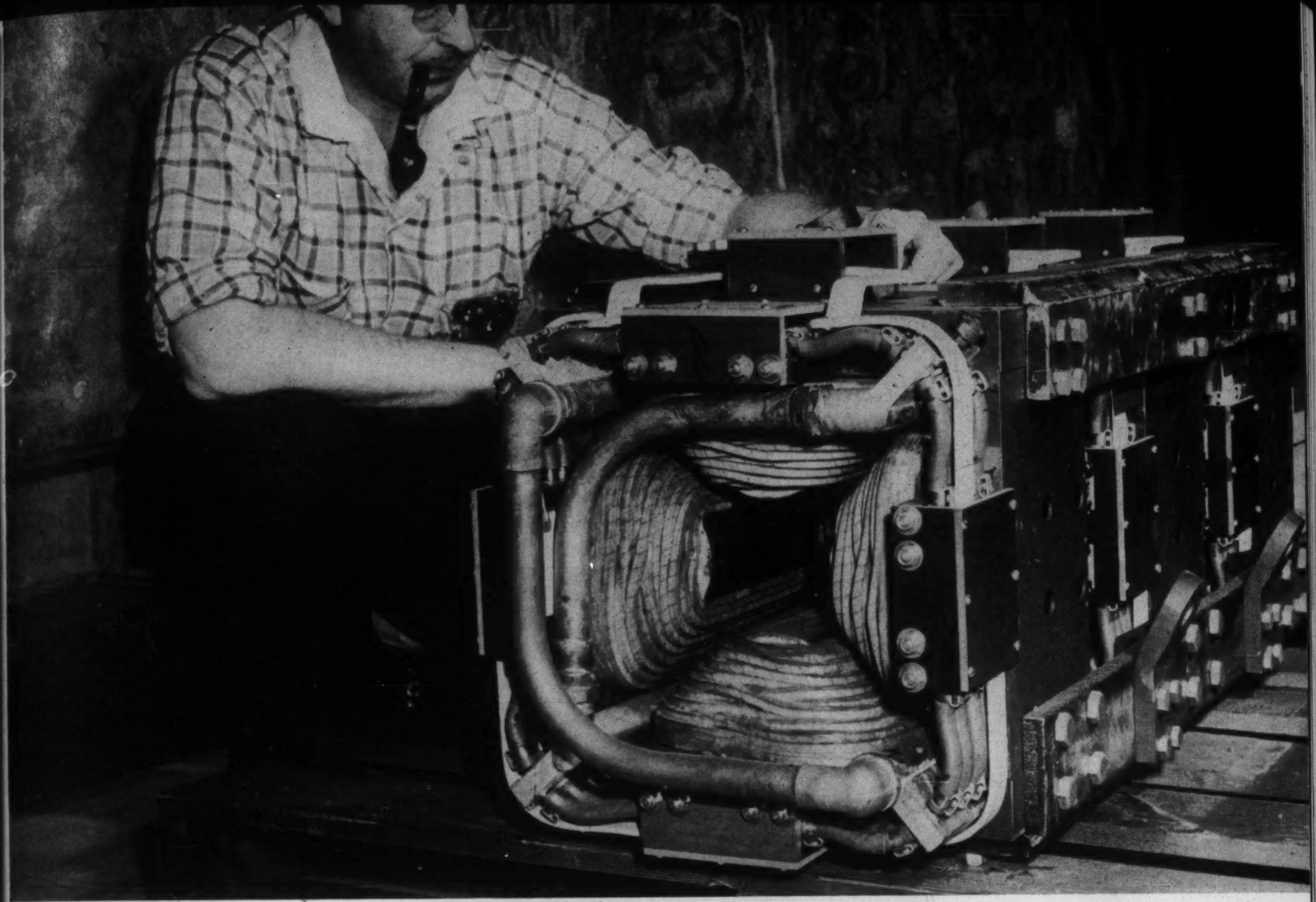




Coils were wrapped, ¾ lap, with 0.001 x 1 in. Mylar tape. Tapped conductor was then spaced with fish paper 2 in. long by 0.015 in. thick, alternately placed vertically and horizontally. Outer surfaces were taped with 0.015 in. fish paper scuff strips and the assembly was packaged with an adhesive glass tape. The outside taped surface is coated with cold curing epoxy resin to form an actual vacuum tight cocoon.

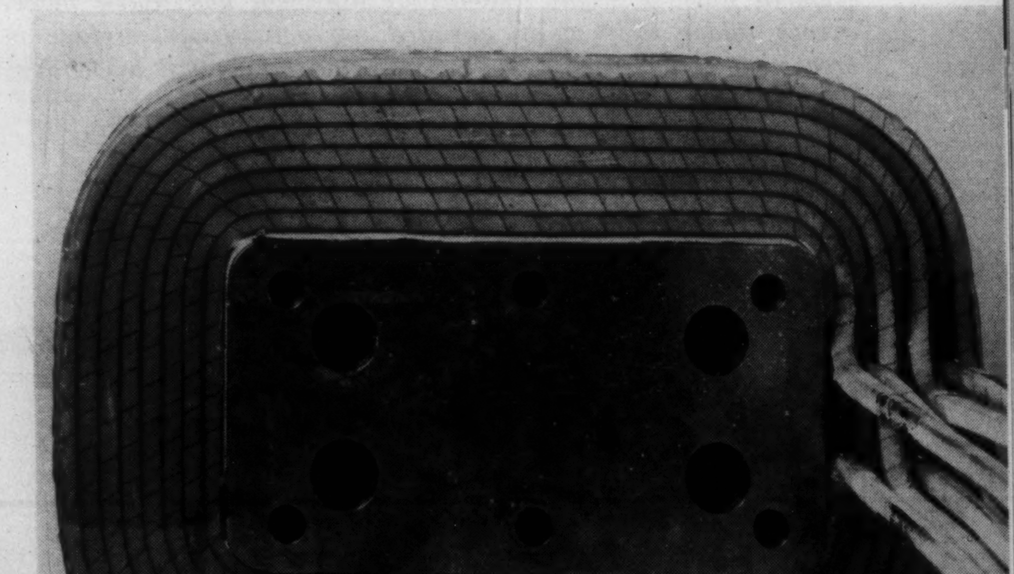


When the outside surface has set, the coil space is evacuated and, after the entire assembly has been warmed with heat lamps, resin is introduced. The syrup is vacuum-deaerated and warmed before being sucked into the cocoon by the cocoon vacuum. The complete coil emerges with a highly scuff resistant case, well packaged mechanically with a very good space factor. Approximately 200 man hr were required to prepare four coils.

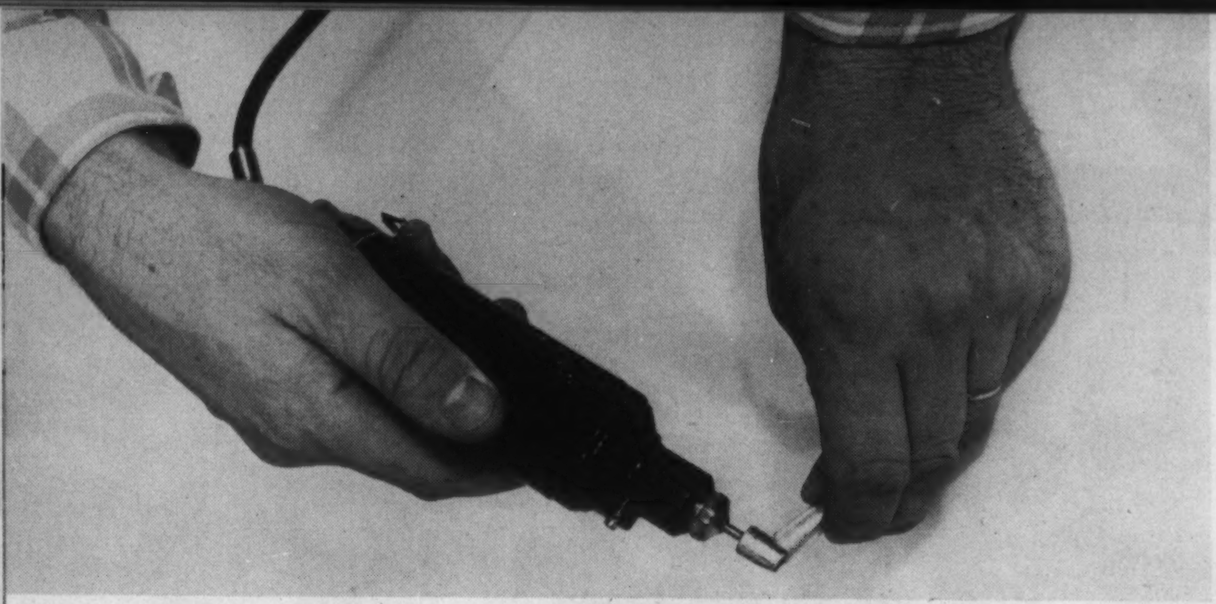


4. Focusing Lens Magnet

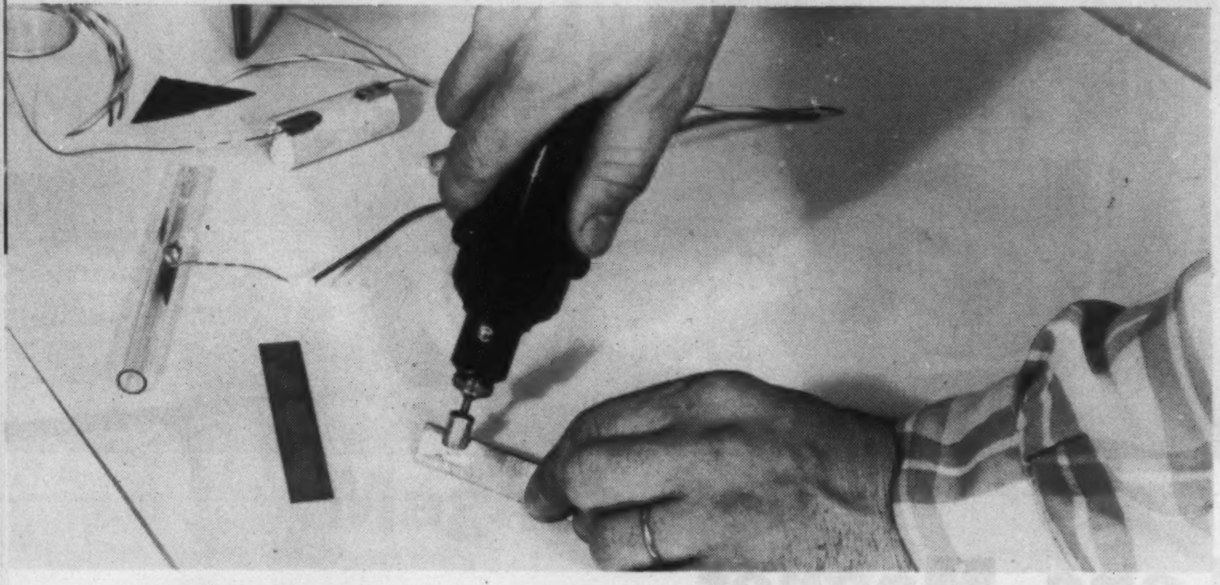
Epoxy resins solved the following design requirements in the construction of a focusing lens magnet used in the UCRL Bevatron by: a) assuring adequate insulation, b) mechanically holding the coil to the pole tip, and c) providing an exterior surface that will shed dirt, metallic chips and other foreign material that could cause electrical trouble.



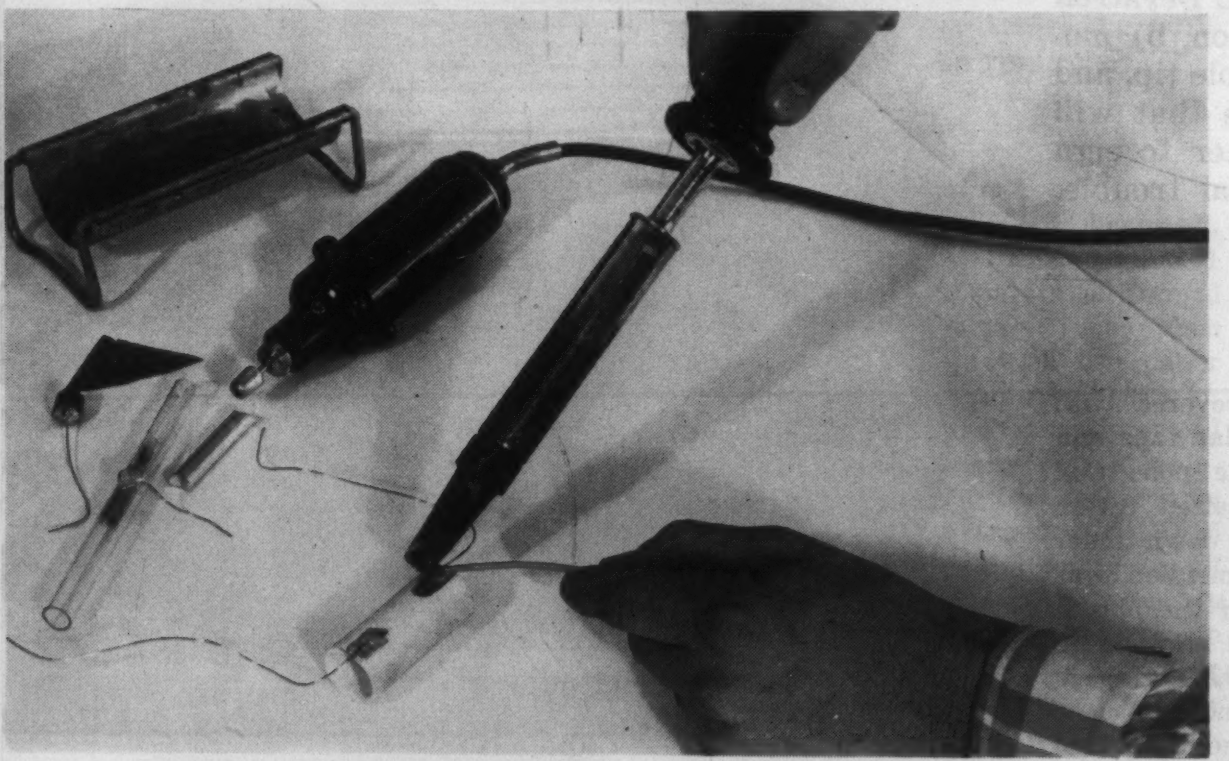
Ends of the pole pieces were covered with 0.005-in. fish paper secured with **Mylar tape** and the coil was wound directly on the pole. Coil insulation was half-lap-wrapped unsized cotton tape, 0.014 x 1 in. Impregnation was down under vacuum. Approximately 30 min immersion was required to obtain full penetration of the plastic throughout the coil. The coil is baked flat side up after impregnation has gelled, a rubber ring is snapped over the coil periphery and sufficient additional plastic is poured into the cavity to cover the flat face of the coil. After the assembly has cooled, cold curing resin is applied to the pyramidal side to develop a glossy, continuous foreign-body-excluding case.



Step 1. ***Abrasive wheel*** *(preferably medium grit, ¼ in. dia, ½ in. long) is "loaded" by warming it and bearing on Wood's metal or 60-40 lead-tin solder.*



Step 2. ***Solder loaded wheel*** *is then applied to surface to be soldered until a slight amount of abrasion has taken place. Friction heat causes solder to flow on abraded surface. Other surface is given similar treatment if it is not a material ordinarily wetted by solder.*



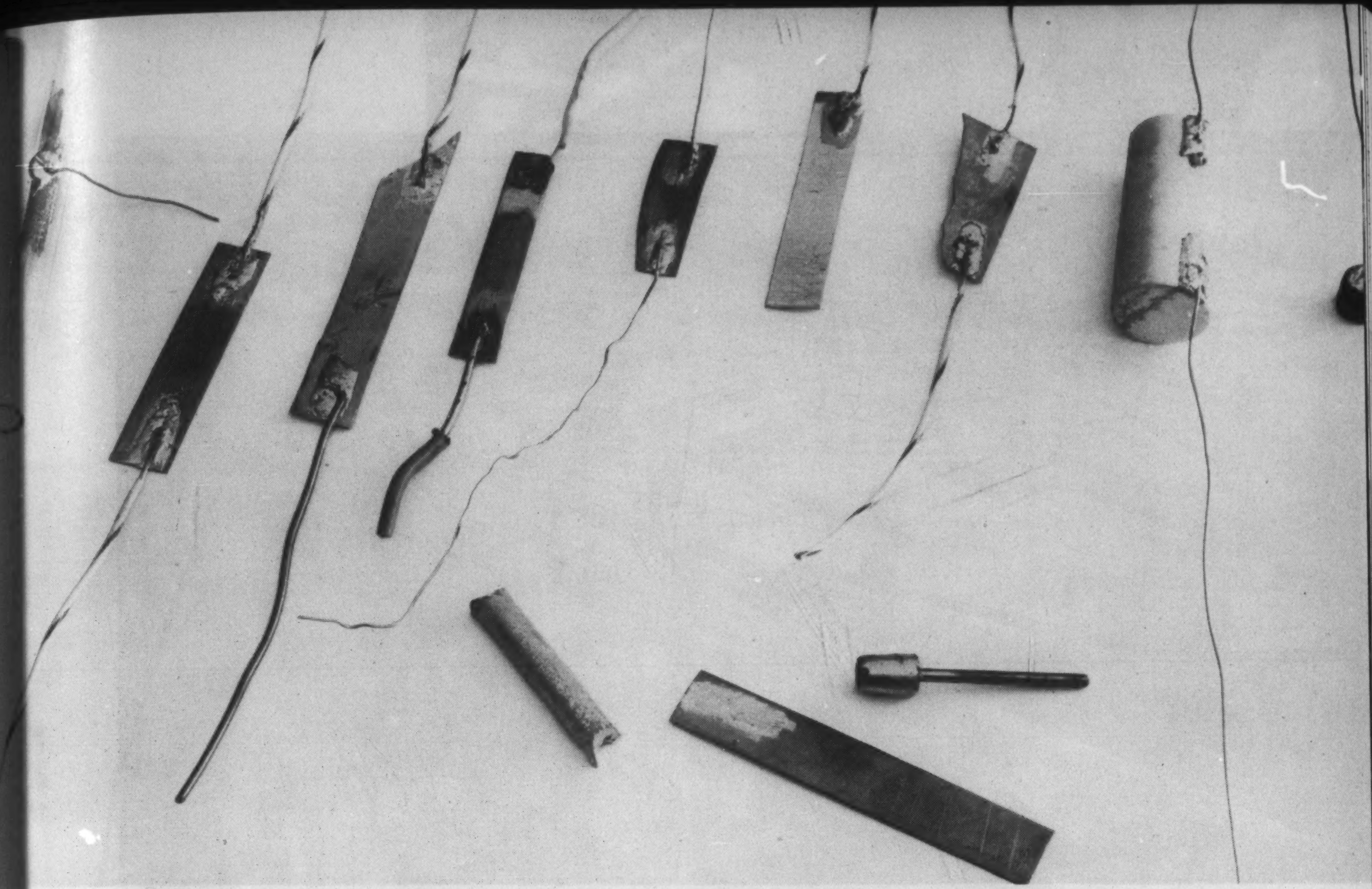
Step 3. ***Soldering*** *is done in usual manner with standard 50-50 lead-tin solder. No soldering flux, surface cleaning or pretreatment is necessary.*

This new method permits

■ An unusual but simple technique permits soldering such materials as aluminum, stainless steel, glass and ceramics without special equipment. Developed by Joseph C. McGuire of the University of California's Los Alamos Scientific Laboratory, the basic equipment for the technique is a medium grit grinding wheel loaded with solder.

The technique

The loaded grinder head is passed back and forth over the spot to be tinned. The tinning layer will be laid down as a shiny spot or strip and will have little ridges of excess alloy following the wheel as it moves. It is helpful to warm the material to be



Materials soldered *by the Los Alamos technique include: (top) Pyrex glass, titanium, molydenum, aluminum, tantalum, stainless steel, tungsten, ceramic, and cobalt. Bottom row illustrates sample of Wood's metal, tinned stainless steel and "loaded" grinding wheel.*

Soldering Difficult Materials

tinned with a hot soldering iron prior to applying the grinding wheel.

When working with glass, failure to deposit a satisfactory coating with Wood's metal indicates that the wheel was too cold when loaded or that it was not completely loaded with Wood's metal. If rotational speed is too high the Wood's metal will be laid down as a black deposit on the glass and the solder will not adhere. The speed should then be cut down until a shiny coating can be deposited. The black deposit will also appear if there is grease or oil on the glass.

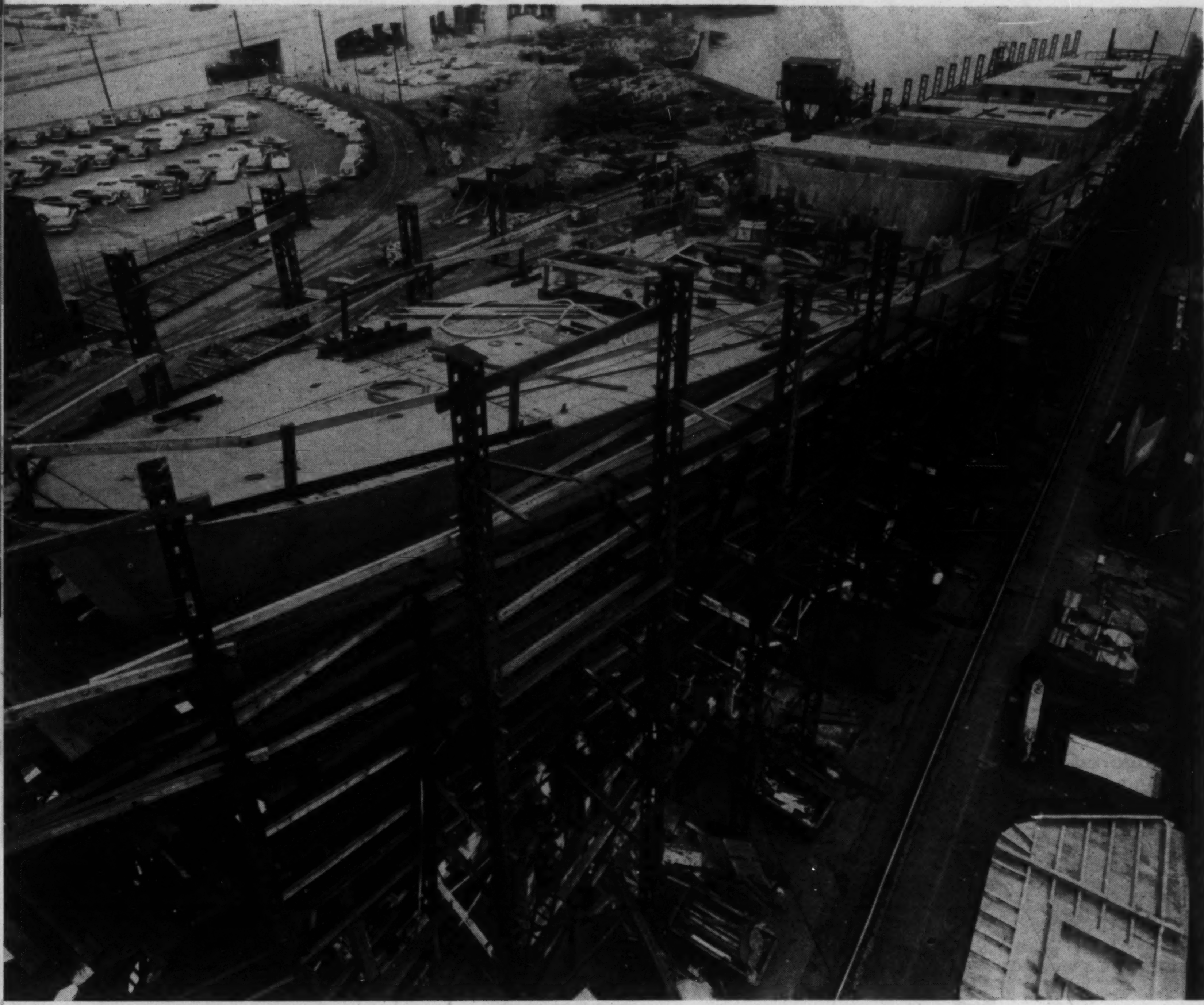
When soldering glass to glass or ceramic, it is necessary to use a flame or furnace to preheat material to be soldered.

After tinning the solder is applied with a soldering iron, but the hot iron should be kept from touching the sub-surface layer of base metal. Heat should be applied by either applying the hot iron to some adjacent part of the metal which is not tinned and then applying the solder in wire form directly to the tinned surface, or by applying the solder to the iron and bringing the hot drop of solder down to the tinned area without bringing the iron into actual contact with the base metal. This is particularly important when soldering titanium, niobium and tantalum.

Solders used

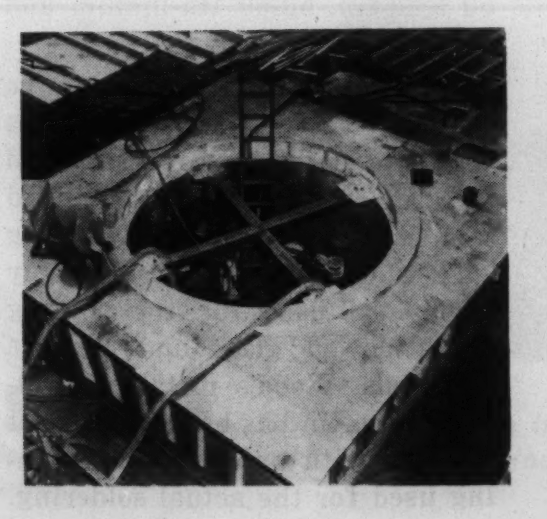
Many of the low melting alloys with melting points ranging from 104 F to 284 F have been used, and all are suitable for tinning. Solders used include 40-60 and 50-50 lead-tin, 50-50 tin-indium and 50-50 lead-indium.

The 50-50 tin-indium may be applied very easily to Pyrex glass without the usual degreasing and heating cycles, and once applied will take the higher melting solders. Ordinary solders probably cannot be used for the tinning operation on glass and ceramic materials. Wood's metal plus 50-50 indium-tin has been found best for this with ordinary solder being used for the actual soldering.



MATERIALS AT WORK

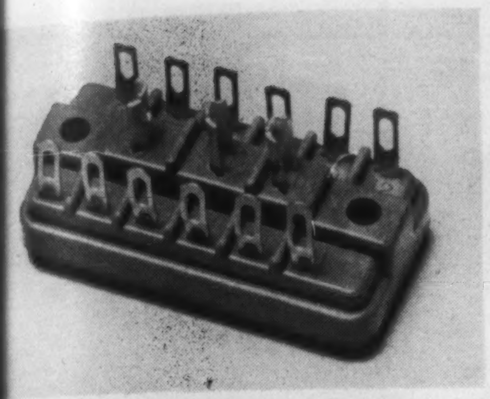
New destroyers use more aluminum

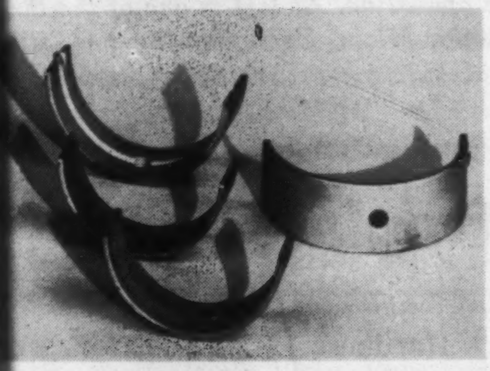


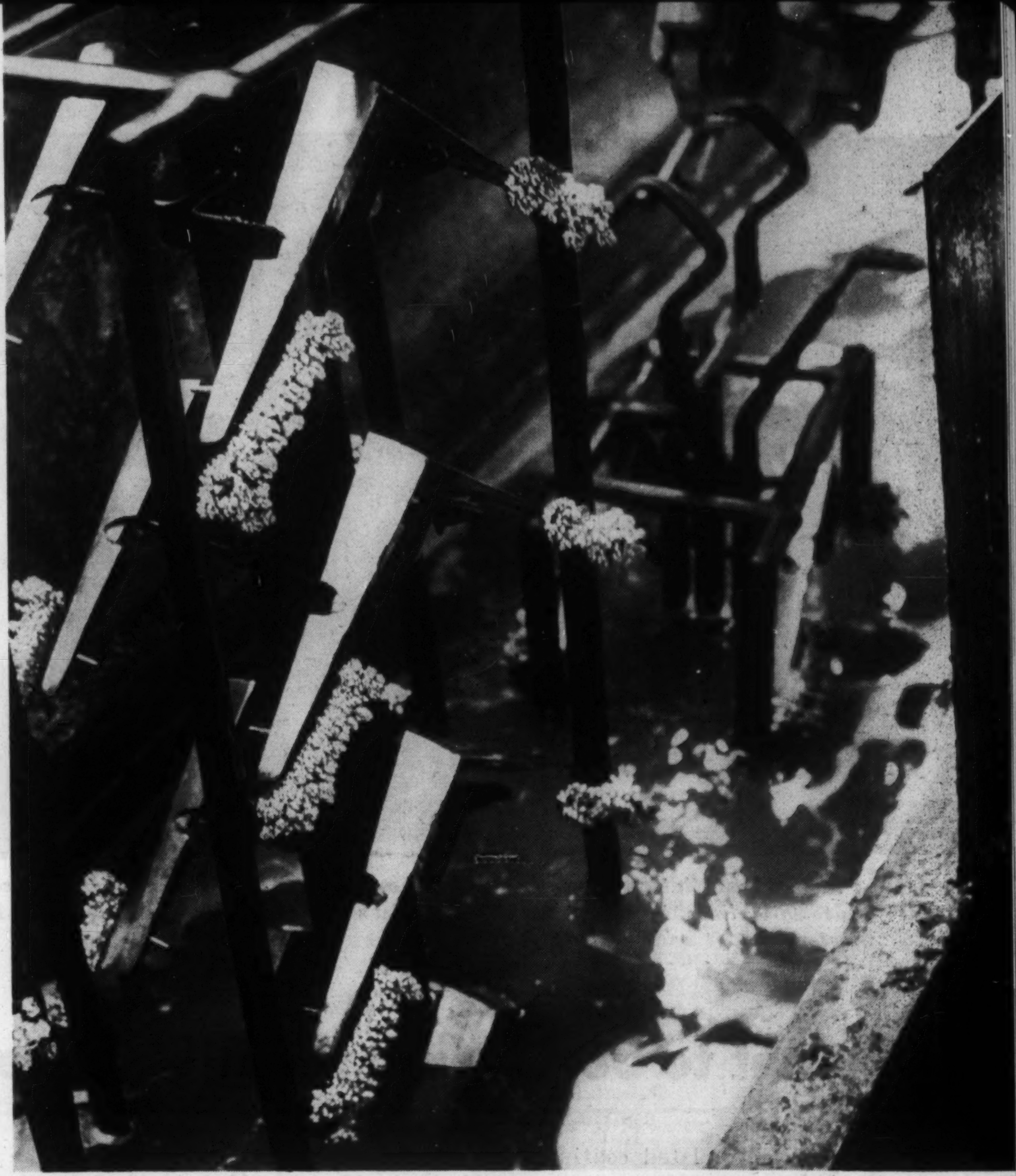
Aluminum superstructure is in the process of construction on one of the U. S. Navy's DD 931 class destroyers at Quincy, Mass., shipyard of Bethlehem Steel Co., Shipbuilding Div. These new destroyers, first designed since World War II, are being built of aluminum almost entirely above deck level and using aluminum extensively below deck.

Kaiser Aluminum & Chemical Corp. is supplying a major portion of the aluminum. The upper gun mount, shown in the photograph at left, is higher above deck than previously. Use of 5083 aluminum keeps weight of superstructure down and prevents detroyer from being top-heavy.

Deck housings are constructed of 6061-T6 sheet and plate with an anti-sweat compound applied where condensation is apt to be heavy. In the ventilating system the air ducts are made of 5052-H32 and -H34 aluminum alloy. Other uses include: small ammunition holders, extruded shapes; ladders, 6061-T6 sheet, plate and extrusions; lockers, 5052-H32 sheet; piping, 6061-T6 tubing.







Lee Silver Service, Inc.

MATERIALS & METHODS MANUAL No. 128

This is another in a series of comprehensive articles on ngineering materials. These ections provide the reader with useful data on characteristics and uses of materials, parts and finishes.

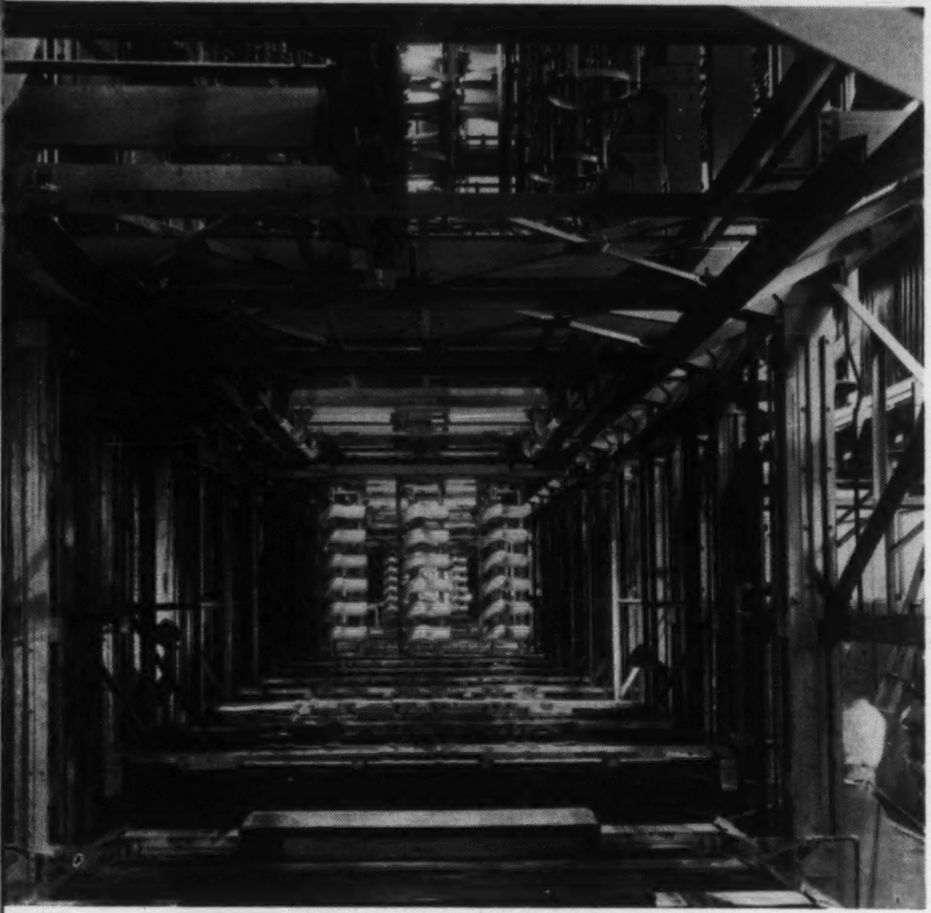
Electroplated Coatings

by J. B. Mohler, *Research Chemist, Kaiser Aluminum & Chemical Corp.**

This manual covers electroplated coatings that are of greatest commercial importance today. It is intended to help the designer of a metal product select an electroplated coating for decorative or functional purposes. The discussion includes:

- *What to consider in specifying electroplates*
- *Characteristics of common electroplates*
- *Use of electroplates—where and why*

** formerly Consultant on Metal Finishing*



Plating installations *vary in size, as shown here. At right is a laboratory scale operation. At left is one of the three automatic lines in operation at Chevrolet's spring and bumper plant at Livonia, Mich. Each bumper line is 535 ft long, 17 ft wide and 25 ft high.*

What to Consider in Specifying Electroplates

■ An electroplated coating is applied by making the base metal cathodic in an aqueous solution of a salt of the coating metal, then passing direct electric current through the solution to precipitate the coating metal by electrolysis. Anodes of the coating metal are used to complete the circuit and replenish the solution. Properties of the coating vary with the composition of the plating solution, current density, agitation, solution pH and solution temperature.

The characteristics of the various electroplated coatings are discussed in the second part of this manual. Before considering in detail the properties, cost and plating characteristics associated with specific electroplates, however, it is necessary to consider several other factors that must be established in selecting an electroplated coating. These are: the surface properties that are important, the significant surfaces and their accessibility (i.e., the design of the part), and the nature of the base metal.

Plate properties

Hardness and corrosion resistance are generally important, since the life of a deposit is usually dependent on resistance to wear and corrosion. For some applications, however, these properties may have to be supplemented by others, or they may even be of secondary importance because of the need for economy.

Hardness—Each metal has its own hardness range (see Table 1). Nothing can be done to deposit soft chromium to the same hardness as hard lead. Within the hardness range for a particular metal, however, there is considerable choice. The properties of 150 Brinell nickel plate are quite different from those of 500 Brinell nickel plate.

Hardness is associated with good wear resistance, but it is also associated with brittleness, high internal stress, low ductility and poor buffability. These properties, undesirable and at times intolerable, are characteristic of harder metals and of any metal at the high end of its hardness range. Bright deposits are also

TABLE 1—HARDNESS OF ELECTRODEPOSITED METALS

Metal	Brinell Hardness
Cadmium	35–50
Chromium	700–1000
Copper	60–150
Gold	5
Iron	150–300
Lead	5
Nickel	150–500
Rhodium	400–800
Silver	50–150
Tin	5
Zinc	40–50

hard, brittle and stressed.

Chromium may be regarded as a desirable standard for wear resistance. The hardness of hard chromium deposits is in the range of 600 to 1000 Brinell.

Corrosion resistance — Practically nothing can be done to change the corrosion resistance of a metal. This property is the same whether the metal is hard or soft. Corrosion *protection* can be improved to some extent by adjusting plating conditions to avoid porous deposits. Hard chromium, for example, is laced with a network of cracks and gives poor protection. Soft chromium is free of these cracks and can be used for corrosion protection.

Buffability — Today many metals can be deposited bright from proprietary baths, thereby reducing buffing costs. It is common practice to buff the softer underlying metal, then plate a bright, hard deposit. If the base metal is etched during preparation or if it is difficult to buff, it becomes desirable to buff the intermediate or final deposit.

Where buffing is required, softer metals and softer deposits are preferred. For example, suppose that a nickel plus chromium plate is desired. One approach would be to deposit and buff soft nickel. A more common practice where the base metal is not too hard is to buff the base metal, then plate bright nickel and bright chromium. Bright copper is sometimes plated prior to nickel and chromium. Another method is to plate and buff copper, then plate bright nickel and chromium, since copper is more easily buffed than nickel, chromium or, in some cases, the base metal. Buffing may be further reduced by using a bright copper plate. In general, the use of a buffable metal at the right point in the finishing process can make a considerable difference in final cost.

Other Metallic Coatings

In specifying a metallic coating, consideration should be given to methods other than electroplating. The most important processes are outlined briefly below (a fuller discussion will be found in M&M Manual No. 19, Sep '55, pp 125-130).

Immersion coatings

An immersion coating is produced by immersing the base metal in an aqueous solution containing ions of the coating metal. No electric current is required, and coatings are highly uniform. Immersion coatings produced by simple displacement are usually quite thin since deposition continues only as long as the base metal is exposed to the solution. Thicker coatings can sometimes be obtained by a chemical reduction process ("electroless nickel") or by other techniques. Common coating metals: tin, nickel and nickel-phosphorous.

Hot dip coatings

A hot dip coating is obtained by immersing the base metal in a bath of the molten coating metal. Fairly thick coatings of inexpensive metals can be obtained more cheaply by hot dipping than by electroplating. Coating metals must be relatively low-melting and base metals relatively high-melting. Common coating metals: zinc, tin, lead-tin and aluminum.

Sprayed coatings

A sprayed coating is usually obtained by automatically drawing coating metal wire through a nozzle where it is melted in a gas flame and atomized by a blast of compressed air which carries the coating particles to the metal. Sprayed coatings are fairly hard and often have excellent wear resistance. Adhesion is not equal to that of plated or hot dip coatings. Common coating metals: zinc, aluminum, molybdenum and wear resistant alloys.

Vapor-deposited coatings

A vapor-deposited coating consists of a metal film condensed from the vapor phase. The vapor may be produced by heating the metal coating in a very high vacuum ("vacuum metallizing"), applying a high voltage between the coating metal and the base metal in a vacuum, or reducing or thermally decomposing a volatile compound of the coating metal. Vacuum metallized coatings, the most common type, are bright, exceptionally thin, and tend to reproduce exactly the surface on which they are applied. They have little inherent abrasion resistance but can be protected by lacquer films. Common coating metals: aluminum and selenium.

Fused coatings

Fused coatings are applied by fusing the coating metal to the base metal. They may be applied by welding, using an electrode containing the coating metal; they may be sprayed on as a powder or paste, then fused; or they may be welded on as inserts. Many different ferrous and nonferrous alloys, as well as tungsten carbide, are used.

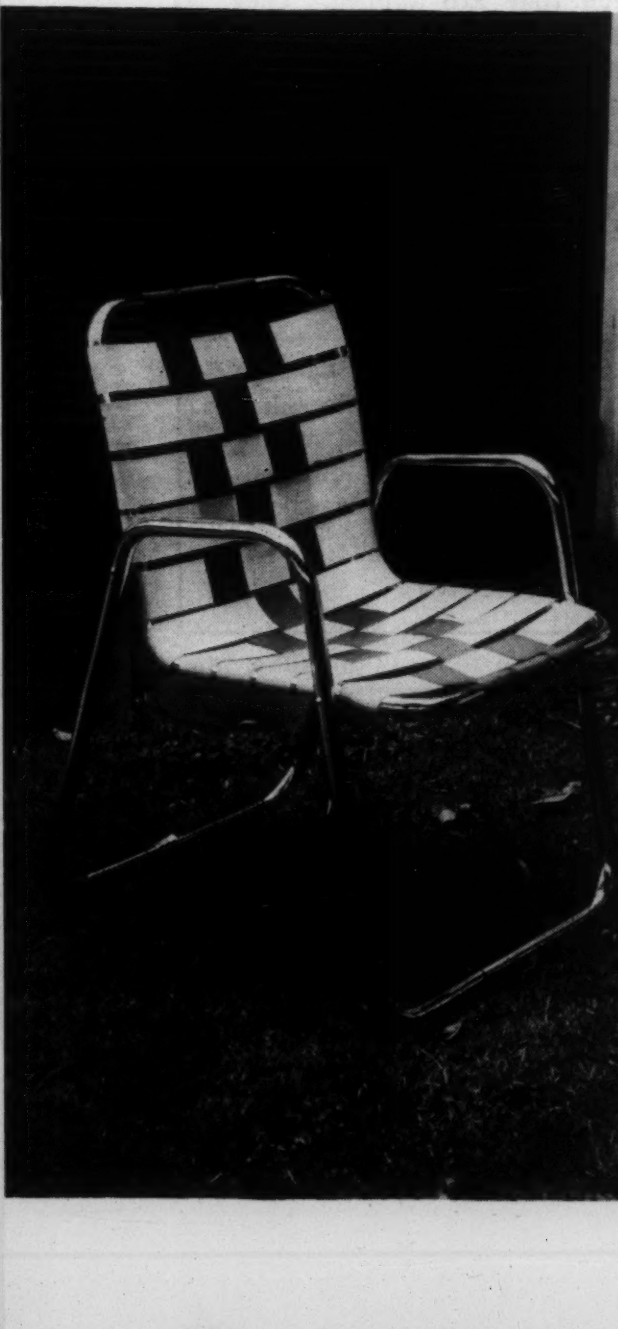
Ductility—A hard, thick electrodeposit will crack, peel or break from the base metal if the plated work is bent. Thin or soft electrodeposits, on the other hand, can be drawn and formed, and such deposits must be specified for parts to be subsequently formed. Soft coatings, such as copper, act as a lubricant for steel, enabling deeper draws to be made. After forming, a part can be buffed and plated with a hard, bright deposit to obliterate scratches or marks produced during the forming operation.

Solderability—If a part is to be soldered after plating, solderability of the electrodeposit becomes important. Tin, tin alloys and lead-tin alloys are easily soldered. Since the tin alloys, such as tin-copper and tin-zinc-copper, have good corrosion resistance, hardness and brightness along with good solderability, they have found increased use in electrical instruments. A tin plate over a copper plate also offers a good combination of corrosion re-

Aluminum Co. of America

Aluminum products *are often electroplated despite aluminum's generally attractive appearance and good corrosion resistance. Lawn chair at bottom was nickel plated. Household utensils at top were nickel and chromium plated.*

Troy Sunshade Corp.



sistance and solderability. Another electrodeposit having good solderability is silver, widely used for electrical connections.

Reflectivity — Highly reflective surfaces are attractive for decorative purposes and are also functional as reflectors behind lamps and heaters. Chromium, silver (lacquered) and tin-copper alloy plates are used for such applications. Gold is used to reflect infrared light. Reflectivities of various electroplates are compared in Table 2.

Design of part

In any electroplating bath, metal surfaces nearest to the anodes tend to receive a heavier coating than more distant surfaces. However, the drop in coating efficiency with distance from the anode is much greater in some baths than in others. Baths in which the drop is not so great are said to have "good throwing power."

The throwing power of cyanide and alkaline baths is good, and complicated shapes can be covered with better uniformity in such baths than in others. The throwing power of acid baths is poor by comparison, and the throwing power of the chromium bath is very poor. Deep recesses, sharp corners and complicated shapes should be avoided in any case, but especially where nickel or chromium are to be plated.

One way to produce a coating on a complex part is to deposit a soft, ductile, buffable deposit be-

TABLE 2—REFLECTIVITY OF BRIGHT METALS (FRESHLY DEPOSITED)

Metal	Reflectivity
Cadmium	52
Chromium	67
Copper	62
Gold	61[a]
Nickel	62
Rhodium	72
Silver	95
Tin	70
Zinc	55

[a] Infrared: 98%

TABLE 3—SPECIFICATIONS ON THICKNESS OF ELECTRODEPOSITED COATINGS

Zinc on Steel (**ASTM A 164-55**)

Type	Min Thk., Mil	Comparable Specifications
GS	1.0	1—Fed. QQ-2-325
LS	0.50	2—Fed. QQ-2-325 Locks, door trim—Fed. FF-H-106a Shelf and misc. hardware—Fed. FF-H-111a Hinges—Fed. FF-H-116b Electrical outlet boxes (outside)—Fed. W-O-821a Electrical metallic tubing—Fed. WN-T-806b
RS	0.15	Electrical outlet boxes (inside)—Fed. W-O-821a

fore forming, then form the part and buff it. It will not be possible to buff sharp inside corners and deep recesses, but such areas will be covered with metal and protected. Another way is to use conforming anodes, i.e., interior anodes and other anodes that conform to the shape of the part, but the expense of this procedure is rarely justified.

The base metal

Plating practice and the composite layers used differ for various base metals. Steel, copper alloys and zinc alloys are most commonly plated. Whereas steel and zinc are often plated with copper plus nickel plus chromium, the copper underlayer is naturally not required for copper alloys. Tin and lead are not sacrificially protective for steel, so an underlayer is often required. However, these same metals *are* sacrificially protective for copper alloys and may be applied directly.

If aluminum is to be plated it should be covered completely, since it will otherwise tend to corrode in preference to the common electroplates. General practice for plating aluminum is to immersion plate zinc, plate copper from a cyanide bath, then deposit the desired top plate. Although aluminum is frequently plated, anodizing is more common where good atmosphere resistance or wear resistance is desired. Anodized coatings can be dyed to produce a variety of attractive colors.

The specification

All plating should be done in accordance with a specification. A

Lead on Steel (ASTM B200-55T)

Type	Min Thk., Mil	
	Copper	Lead
ES	—	1.0
EES	0.015	1.0
MS	—	0.50
MMS	0.015	0.50
PS	—	0.25
PPS	0.015	0.25

Nickel and Chromium on Steel (ASTM A 160-55T)

Type	Minimum Thickness, Mil			Comparable Specifications
	Copper & Nickel	Nickel	Chromium (if required)	
DS	2.0	1.00	0.010	Type I—Fed. QQ-N-290
FS	1.2	0.60	0.010	Type II—Fed. QQ-N-290 (1.25)
KS	0.75	0.40	0.010	Type III-Fed. QQ-N-290 Dental and surgical instruments—Fed. GG-I-526a
QS	0.40	0.20	0.010	Type IV—Fed. QQ-N-290 Lock and door trim—Fed. FF-H-106a Shelf and misc. hardware—Fed. FF-H-111a Hinges—Fed. FF-H-116b

Cadmium on Steel (ASTM A165-55)

Type	Min Thk., Mil	Comparable Specifications
NS	0.50	A-Fed. QQ-P-416 Hinges—Fed. FF-H-116b Electrical outlet box (outside)—Fed. W-O-821a
OS	0.30	B—Fed. QQ-P-416
TS	0.15	Locks, door trim—Fed. FF-H-106a Shelf and misc. hardware—Fed. FF-H-111a Electrical outlet box (inside)—Fed. W-O-821a C—Fed. QQ-P-416 (0.20) Steel lag bolts—Fed. FF-B-561a (0.20)

Nickel and Chromium on Copper and Copper Alloys (ASTM B141-55)

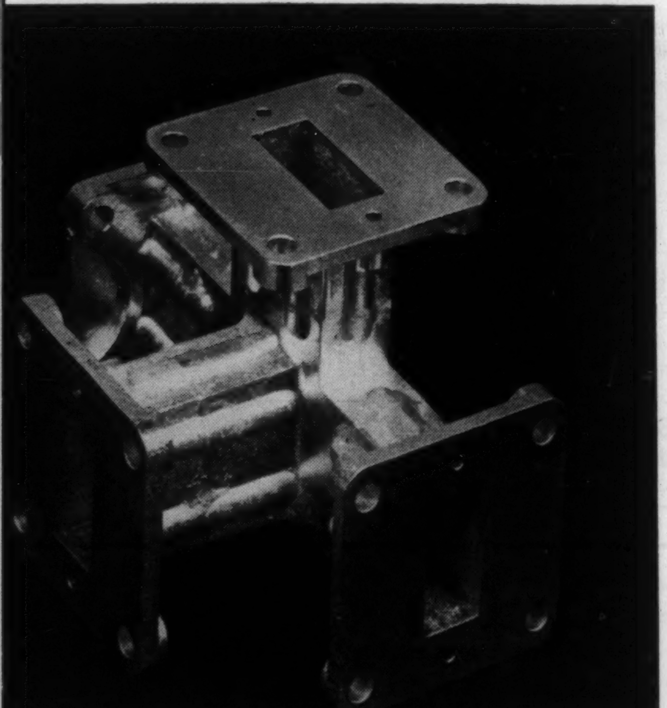
Type	Minimum thk., mil		Comparable Specifications
	Nickel	Chromium (if required)	
FC	0.50	0.010	V—Fed. QQ-N-290
KC	0.30	0.010	VI—Fed. QQ-N-290 Dental and surgical instruments—Fed. GG-I-526a
QC	0.10	0.010	Locks, door trim—Fed. FF-H-106a Shelf and misc. hardware—Fed. FF-H-111a

Nickel and Chromium on Zinc and Zinc Alloys (ASTM B142-55)

Type	Minimum Thickness, Mil				Comparable Specifications
	Copper & Nickel	Copper	Nickel	Chromium (if required)	
FZ	1.20	0.20	0.50	0.010	VIII—Fed. QQ-N-290 (1.25)
KZ	0.75	0.20	0.30	0.010	IX—Fed. QQ-N-290
QZ	0.50[a]	0.20	0.30	0.010	Locks, door trim—Fed. FF-H-106a Shelf and misc. hardware— Fed. FF-H-111a

[a] Total of 0.30 mil if nickel only is used.

Decorative effect *on automobile hub caps is achieved by reflective nickel plus chromium electroplate.*



Special properties *often call for special electroplates. A good example is this waveguide which must have a surface that generates a low noise voltage, thereby causing minimum distortion of the signal transmitted. Rhodium, as yet not generally available in job plating shops, meets this requirement.*

specification may be a detailed agreement between the manufacturer and the purchaser, a designation on a print, a defined operating procedure for the process, or an agreement with the plating department. In any case, the specification should be precise. Loose terms, such as "thin deposit," "heavy deposit" or "flash" should not be used without a definition.

Government, military, society and commercial specifications are used to define processes, procedures, testing methods and the thickness of deposits. The specifications and tests compiled by Committee B-8 of the American Society for Testing Materials are frequently used as a common ground for agreement (see Table 3). These ASTM specifications offer a means of defining the thickness of electroplates.

Anyone desiring work to such a specification should obtain a copy of the appropriate specification and be sure he understands all that it implies. Although such specifications define thickness, sampling, testing, acceptance and rejection, they divide the responsibility between the manufacturer and the purchaser, and they leave the definition of "significant surfaces" up to the parties concerned. Significant surfaces are those visible surfaces which are subject to wear and corrosion, and these are the surfaces for which the minimum thickness is specified.

A specification that is difficult will add to the cost of plating. A practical specification is one that is as simple as possible, yet completely adequate to insure that the desired quality is consistently obtained. If the plating requirement is not critical and the plating bath is controlled, a definition of work area per load, plating time and current density is often sufficient, particularly where plating is done within the plant. For outside plating, it is wise to specify the significant surfaces, minimum thickness of the deposit and other tests, such as adhesion and salt spray.

The salt spray test is well known and commonly specified. Unfortunately the test is not too meaningful in many cases, as has been shown by a great deal of testing experience. On the other hand there is no other short-time corrosion testing method that can be used as a reliable indication of general corrosion resistance.

If a corrosion test such as humidity or salt spray is used, it should be kept in mind that the only thing being measured is resistance to the testing environment used. A correlation between such tests and service tests is required to determine the value of short-time testing methods. Where the reliability of a test has not been established, actual or closely simulated service tests are the only dependable tests. A specification on plate thickness at least guarantees the minimum amount of metal that will be present for protective purposes.

Characteristics of Common Electroplates

The metals that are electroplated commercially are cadmium, chromium, copper, gold, iron, lead, nickel, silver, tin and zinc. There is a great difference in the properties of these metals, each metal having a set of properties that makes it most useful for a particular application.

No metallic coating is ideal. For instance, if a coating should be hard to resist wear and should also be easily buffed to keep finishing cost down, then it will be necessary to compromise between the properties of hardness and buffability.

The relative ratings for electrodeposited metals in Table 4 show why one metal is selected over another for a particular application. For example, the table shows that chromium is the hardest and thus the most wear resistant of the metals. Its corrosion resistance is excellent, so it remains bright. However, chromium is costly and, in deposits of practical thickness, offers poor protection against rusting for steel. Zinc, on the other hand, offers excellent protection for steel at low cost, but it is soft and it discolors and corrodes quite easily. Obviously zinc and chromium are not alternative possibilities. More closely akin are chromium and nickel on the one hand and zinc, cadmium and lead on the other.

Although the rough comparison of electrodeposited metals in Table 4 indicates that no two metals have the same over-all rating, it does not tell the whole story. Why use cadmium at all if it has the same properties as zinc, but at a higher cost? The answer is that cadmium has demonstrated its superiority to zinc under certain corrosive conditions—a fact which cannot be reflected in such a general summary as is provided by Table 4.

The properties of the metals are different enough so that, in general, it is not difficult to choose the proper one. However, the choice is not always obvious. Also, the characteristics of the plating baths must be taken into consideration, since plating of an item may be easy in one bath and very difficult in another (see Table 5).

Alloy plates

The plating of alloys is gradually increasing in importance. Pure metal electroplates will continue to be popular because they are well established, they are readily reproducible and they are easier to deposit than alloys. However, the properties of pure metal electrodeposits are limited. Hardness and corrosion resistance, in particular, can be increased by the deposition of alloys. A tin-zinc plate, for example, combines the corrosion resistance of tin with the corrosion protection of zinc.

Brass (copper-zinc) and terne plate (lead-tin) have been deposited for many years, demonstrating that alloy baths are practical and can be controlled. Bronze (copper-tin), tin-zinc, copper-tin-zinc, tin-nickel, nickel-cobalt and a number of other alloys are also being successfully deposited today. In fact, alloy plating reached a stage some time ago where the alloy best suited for a particular application could be selected. The lead-tin-copper and silver-lead alloys used in sleeve bearings are good examples.

Of these alloys, only brass and terne are generally plated on a job shop basis. The other alloys are plated primarily by manufacturers of end products that must meet special requirements. In the future, more alloy compositions of general usefulness will probably be established. Meanwhile it should be realized that proprietary alloy baths are available.

Brass

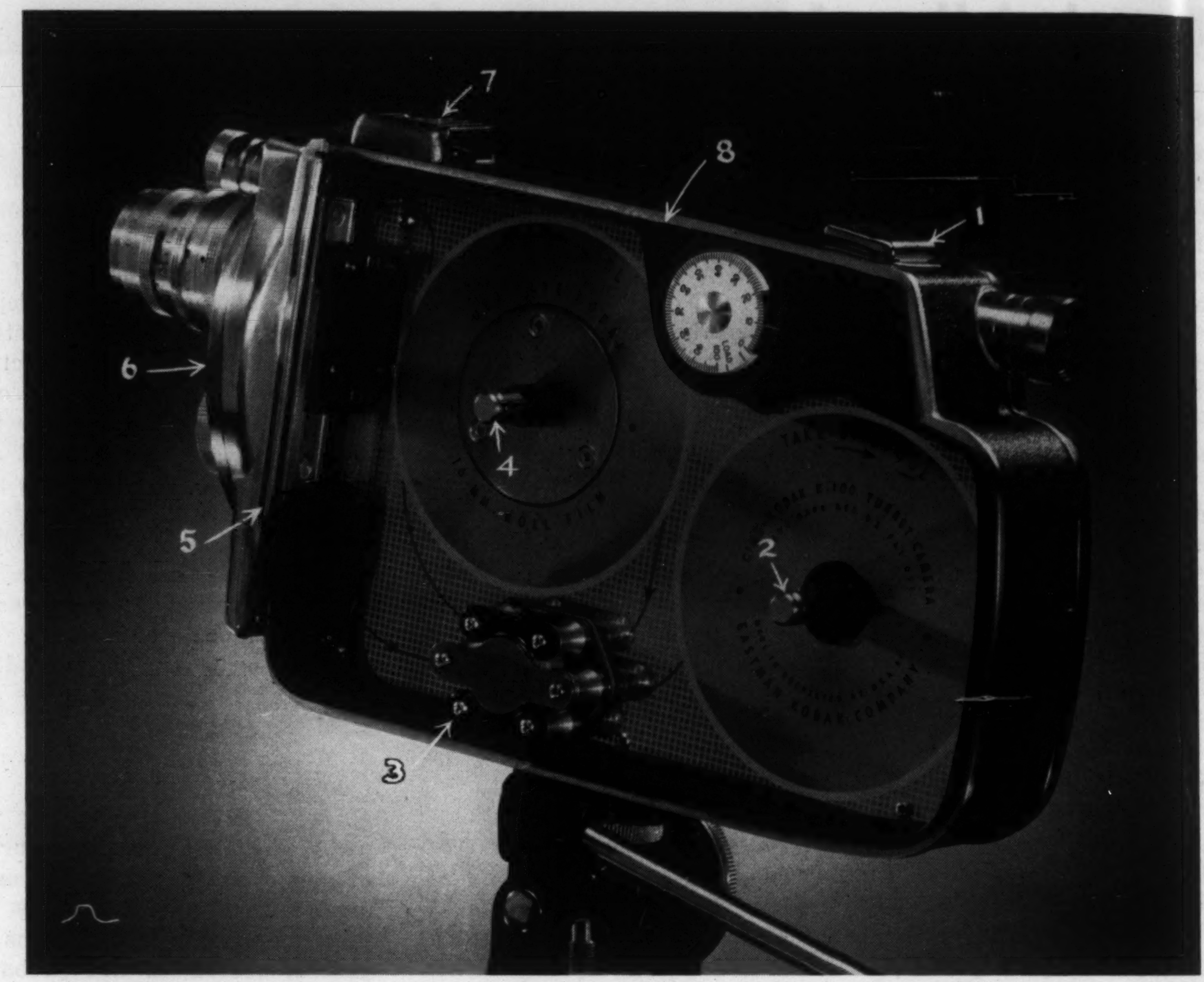
Brass electroplates are used principally where a brass color is desirable. The plate may be used to match the color of solid brass parts or simply for low cost

TABLE 4—SELECTING AN ELECTROPLATE

Metal	Relative Ratings for . . .			
	Hardness	Protection of Steel	Corrosion Resistance	Cost
Cadmium	5	1	3	5
Chromium	1	4	1	6
Copper	4	2	2	2
Gold	6	3	1	8
Iron	3	2	3	2
Lead	6	3	2	3
Nickel	2	2	2	4
Silver	4	3	2	7
Tin	6	3	2	5
Zinc	5	1	3	1

TABLE 5—CHARACTERISTICS OF COMMON PLATING BATHS

Metal	Type of Bath	Preparation for Plating	Cathode Efficiency, %	Current Density, Amp/Sq Ft	Throwing Power	Ease of Control	Appearance of Plate
Brass	Cyanide	Easy	80	3–10	Good	Complex	Good
Cadmium	Cyanide	Easy	90	15–45	Good	Careful	Bright
Chromium	Acid	Easy	25	15–450	Very Poor	Easy	Bright
Copper	Acid	Careful	100	5–75	Poor	Easy	Good
	Cyanide	Easy	60–100	20–100	Good	Careful	Bright
Iron	Acid	Careful	100	5–100	Poor	Careful	Good
Lead	Acid	Careful	100	10–80	Poor	Easy	Dull
Nickel	Acid	Careful	95	15–50	Fair	Complex	Bright
Silver	Cyanide	Careful	100	5–15	Good	Easy	Bright
Tin	Acid	Careful	100	5–50	Poor	Complex	Good
	Alkaline	Easy	40–80	5–60	Excellent	Easy	Good
Zinc	Acid	Careful	100	15–50	Poor	Careful	Good
	Cyanide	Easy	50–80	5–50	Good	Careful	Bright



How Kodak Uses Electroplates in a Movie Camera

A variety of metal finishes are used on this Cine-Kodak K-100 Turret Camera, among them several types of nickel and chromium electroplates on three different kinds of base metal — steel, brass and aluminum. Starting at upper right corner and going clockwise:

1 Rear handle bracket, brass, is tumble-finished, barrel nickel plated, ball burnished and chromium plated.

2 Take-up spool hub, brass, is barrel nickel plated.

3 All screws, steel, are barrel bright nickel plated.

4 Supply spool hub, brass, is barrel nickel plated.

5 Aperture plate, brass, is chromium plated and brushed.

6 Turret, aluminum die casting, is brushed, zinc immersion coated, nickel plated, brushed and chromium plated.

7 Front handle bracket, aluminum die casting, is brushed, zinc immersion coated, nickel plated, brushed and chromium plated.

8 Camera case, aluminum die casting, is brushed, zinc immersion coated, nickel plated, brushed and chromium plated.

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trim. Since an unprotected brass deposit will tarnish, it is usually lacquered to preserve the color.

Brass is deposited from a cyanide bath. Although the bath is somewhat complex, it is controlled to provide the desired color by many job shops.

A bright white brass containing about 75 zinc and 25% copper can be deposited, though it is not a popular alloy.

Bronze

The copper-zinc alloys known as "brass" contain 20 to 30% zinc. An alloy containing about 8% zinc is also deposited and is known as "bronze." The alloy is less yellow and more red than the brass alloys.

In addition, copper-tin bronze alloys are gaining some popularity. These alloys can be deposited with various proportions of tin to obtain a range of hardness and color. The harder alloys may be used for wear resistance and other surface properties. The softer alloys have possibilities as undercoatings, and there is considerable interest in the use of such alloys as a substitute for nickel undercoatings.

Cadmium

Cadmium protects steel by sacrificial corrosion. The properties of cadmium are similar to those of zinc, but cadmium is quite scarce and consequently relatively expensive. Cadmium deposits are specified in marine applications for resistance to moisture and salt spray.

Bright cadmium deposits are obtained from cyanide baths. Both covering power and throwing power of the cyanide bath are good. Also, since cadmium protects steel by sacrificial corrosion, porosity of the deposit is not a problem. Because cadmium plate will discolor in time, it is not suitable as a permanently attractive finish.

Chromium

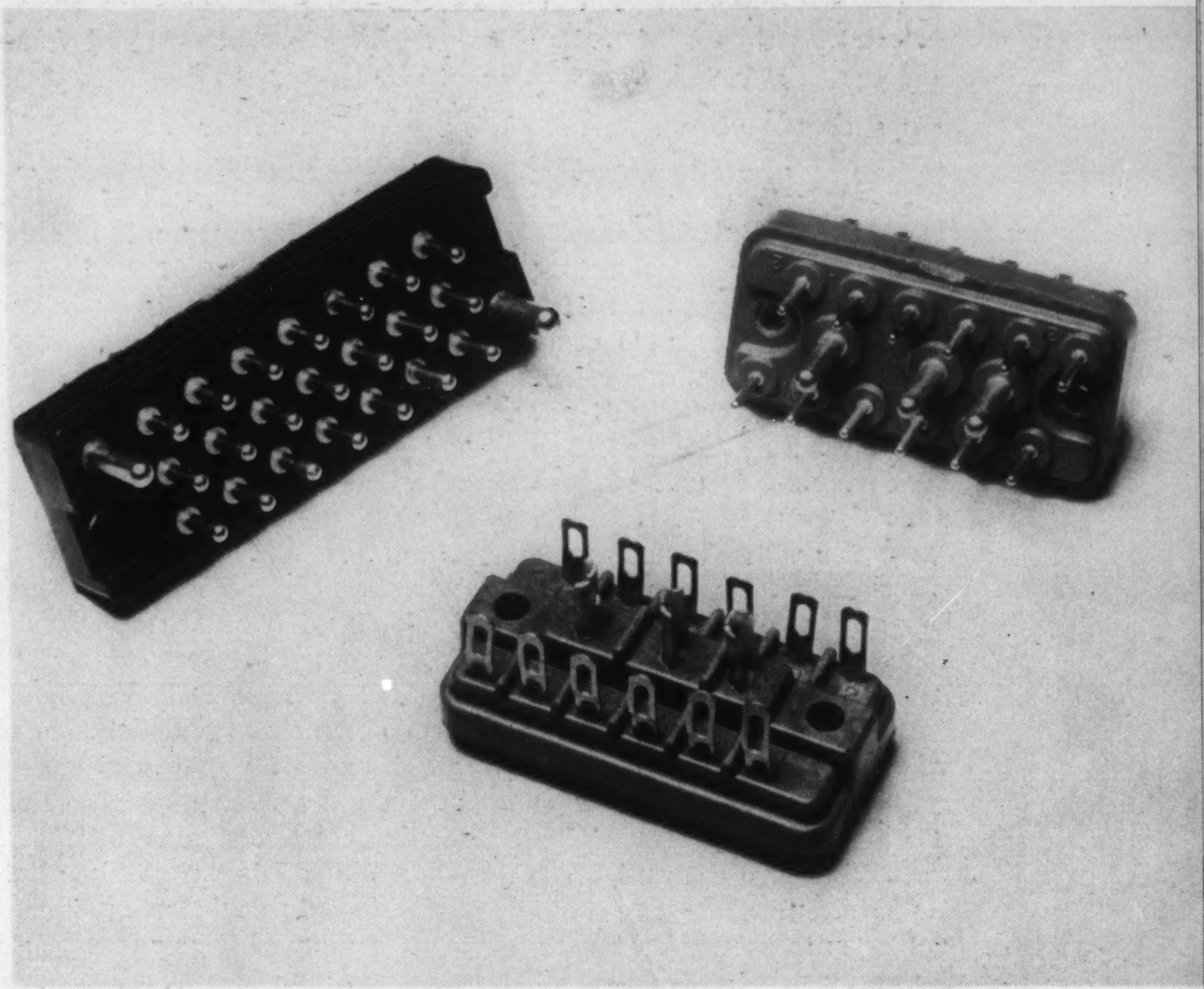
Chromium has a combination of properties that is unmatched by any of the other electroplates. It has high hardness and excellent corrosion resistance. Because it offers resistance to wear and abrasion combined with a permanent bright surface, chromium is popular as a final decorative finish. A thin deposit is applied and undercoats are used to protect the base metal.

In addition to the above properties, a chromium surface has a low coefficient of friction in contact with steel and other metals. Therefore, it is used extensively for the surfaces of such things as cutting tools, bearings, tools, dies, molds and rolls. Heavy "industrial" deposits are widely used to extend the life of machine parts and tools subject to continual wear. Industrial or "hard" chromium and decorative or "bright" chromium are essentially the same. If chromium is bright, it is hard. Both can be plated from the same baths.

The chromium bath has poor throwing power and its plating range is limited. As a result, plating of complicated shapes is very difficult. If complicated designs are required, it is well to consult the plater about the limitations of chromium plating.

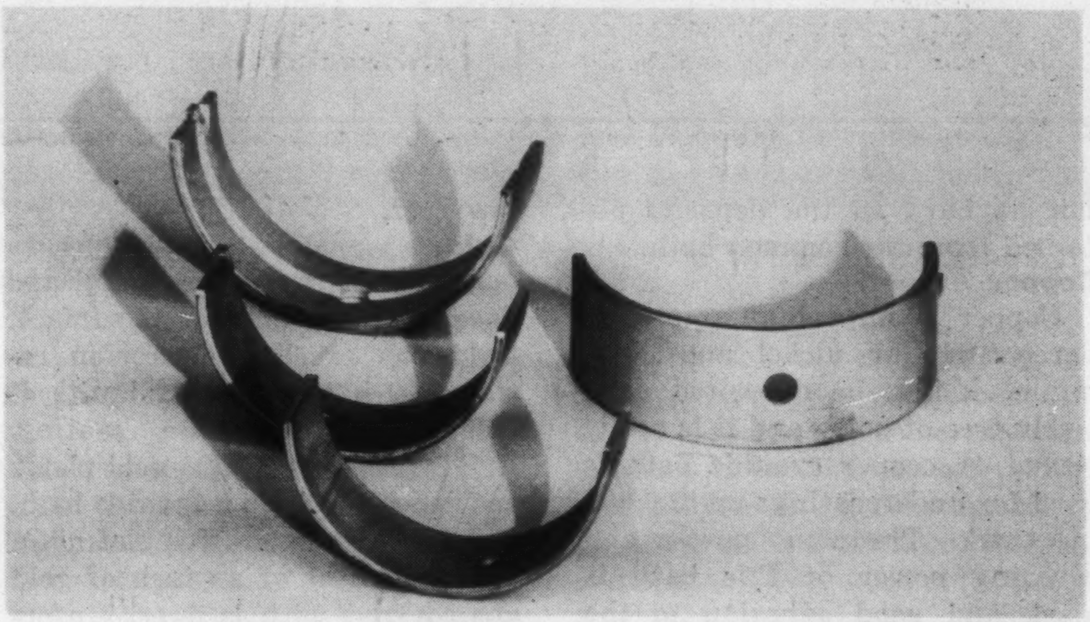
A hard chromium deposit contains minute cracks, is brittle and is highly stressed. Even so, heavy deposits of almost any desired thickness can be produced, then ground to finish size for industrial applications. Some cracking at edges may occur, so it is well to design in such a way that edges can be ground away.

Almost all of the chromium that is deposited is hard and bright. Recently, several baths have been developed for applications where these properties are not of primary importance. A bath for plating crack-free deposits is available for applications where the chromium is to function only as a protective barrier. A relatively soft and ductile chromium can be used where it is desirable to buff



H. H. Buggie Co.

Terminals *on these blocks are gold plated.*



Johnson Bronze Co.

These sleeve bearings *are plated with lead-tin alloy. The 1-mil coating provides a low friction surface for the steel-backed copper-lead bearings.*

Tin Research Institute

Bright, attractive finishes *are provided here by tin-nickel alloy electroplates. These relatively new coatings may become a popular substitute for chromium plate.*

the chromium as a final operation. These deposits are not as bright nor as hard as the deposits obtained from the common bath.

Copper

Copper is important as an undercoating for nickel and chromium. It can be deposited relatively free of pores and it is easily buffed. A copper cyanide bath is used for undercoatings up to 0.002 in. thick. Throwing power and covering power of this bath is good, and good adhesion to the base metal is promoted by the use of low efficiency copper cyanide baths. Because of these properties, copper plated from a cyanide bath is used as a "strike" to promote adhesion in many plating processes. A bright copper deposit can be obtained from a high efficiency cyanide bath and is useful where low finishing cost is desired.

An acid copper bath is used for heavy deposits of copper, as in electrotyping. Deposits of 0.010 to 0.030 in. are easily obtained with simple control and at relatively low cost.

Gold

Gold is a true noble metal and does not form films on its surface. Gold has excellent corrosion resistance, but high cost limits it mostly to decorative plating. Bright, relatively hard gold plates are deposited from a cyanide bath. For low cost decorative plating, a few millionths of an inch of gold are covered with lacquer. Unfortunately such thin gold has a short life after the lacquer is worn off, and the life of the lacquer is short compared to that of metals commonly deposited.

The good conductivity, good solderability and excellent corrosion resistance of gold make it useful for electrical contacts. Usual thickness is 0.0001 to 0.0002 in. Gold plates are also used where good infrared reflectivity is needed.

Iron

Iron is not used for decorative purposes because of its tendency to rust, nor is it a metal commonly plated by job shops. However, electrodeposited iron does have many industrial applications. If a heavy deposit of metal is desired iron should be considered as a low cost method to obtain at least a part of the desired thickness.

Heavy, sound deposits of iron are applied from a number of acid baths. Such deposits are used in electrotyping and electroforming. After being removed from the mold, a formed deposit can be hardened by carburizing or nitriding.

Lead

Lead is useful for resistance to certain corrosive environments, such as battery acid (sulfuric acid). Lead alloys are also applied as bearing surfaces to take advantage of the low coefficient of friction for lead against steel, as well as the ability of this soft metal to conform to the shaft. Heavy deposits of lead and lead alloys can be deposited from acid baths, such as fluoboric acid.

Nickel

Nickel is deposited from a number of different acid baths. Properties of the nickel deposit can be changed considerably by adjusting the bath formulation. As a result, nickel is used for a variety of decorative and functional applications.

Bright nickel plates are widely used—mostly as an undercoating for chromium, although the bright nickel surface itself is sufficiently serviceable for many items.

Hard nickel plates that are not as brittle as the bright deposits are also common. Heavy nickel deposits can be applied at lower cost and with better coverage than chromium. The deposits are not as hard as chromium, but the high hardness of chromium is not always required. The nickel deposits can be buffed and machined, whereas it is necessary to grind hard chromium deposits. Nickel deposits up to ¼ in. have been used in building up worn parts

Corrosion and wear *are often combatted with nickel electroplates such as the highly polished coating on this drum. The drum is used by Eastman Kodak in making photographic film.*

and in electroforming. In some of these applications it is economical to plate a heavy supporting layer of nickel plus a surface layer of chromium.

Soft nickel can be deposited where the plate must be subsequently machined, buffed or formed. Tough nickel plates that are a compromise between the soft and the hard coatings can also be obtained. They are relatively hard, yet not too difficult to form or buff.

The characteristics of a nickel bath can be adjusted for strike plates or for heavy deposits. Although nickel baths are versatile, good control is essential to keep bath characteristics within the range desired. Of course, it is not always possible to match desirable bath properties with desirable plate properties. Compromises must be made and there are at least a dozen popular baths to choose from.

Nickel coatings present a special economic problem, since the metal has been in short supply for some time. The possibility of substitute materials, such as various alloys, is being given serious consideration. Many of these alloys contain tin, however, and the history of the availability of tin must also be weighed.

Silver

Why the public continues to prefer tarnishable silver plate when nontarnishing chromium plate and stainless steel are available is an interesting question, but it is safe to assume that the public will continue to buy silver plate. Silver has a pleasing color, good corrosion resistance, fair resistance to wear, good reflectivity and high conductivity. Although the price of silver is high, its cost is usually a minor factor compared to the total cost of the product. Silver deposits have good coverage, so that deposits of 0.001 in. give good protection and relatively long life.

Silver plating has become important for a number of industrial applications, such as electrical contacts, corrosion resistant containers in the chemical and food industries, and high load sleeve bearings in aircraft.

Efficiency and other characteristics of the silver cyanide bath are good, making the bath relatively simple to operate and control. A bright formulation is available.

Tin

Tin is a soft white metal similar to silver in appearance. It has good corrosion resistance, excellent solderability and good coverage. Like lead it has good antifriction properties, making it useful as a break-in surface or as a permanent bearing surface. Tin is not sacrificially protective for steel, but it is for copper.

A major application for tin plates is tin can stock. Because it is nontoxic, tin plates (or tin plated steel) are popular for food containers and food processing equipment. Tin coatings are also used on copper wire and copper and brass parts where easy soldering is desired.

Tin can be deposited from two types of baths that are quite different. The alkaline bath has the best throwing power and covering power of any of the plating baths, so it is useful for flash plating of thin deposits. Deposits 0.00002 to 0.00005 in. thick impart a white color and give protection to steel for temporary storage up to six months. If such deposits are oiled, two years of shelf life can be expected.

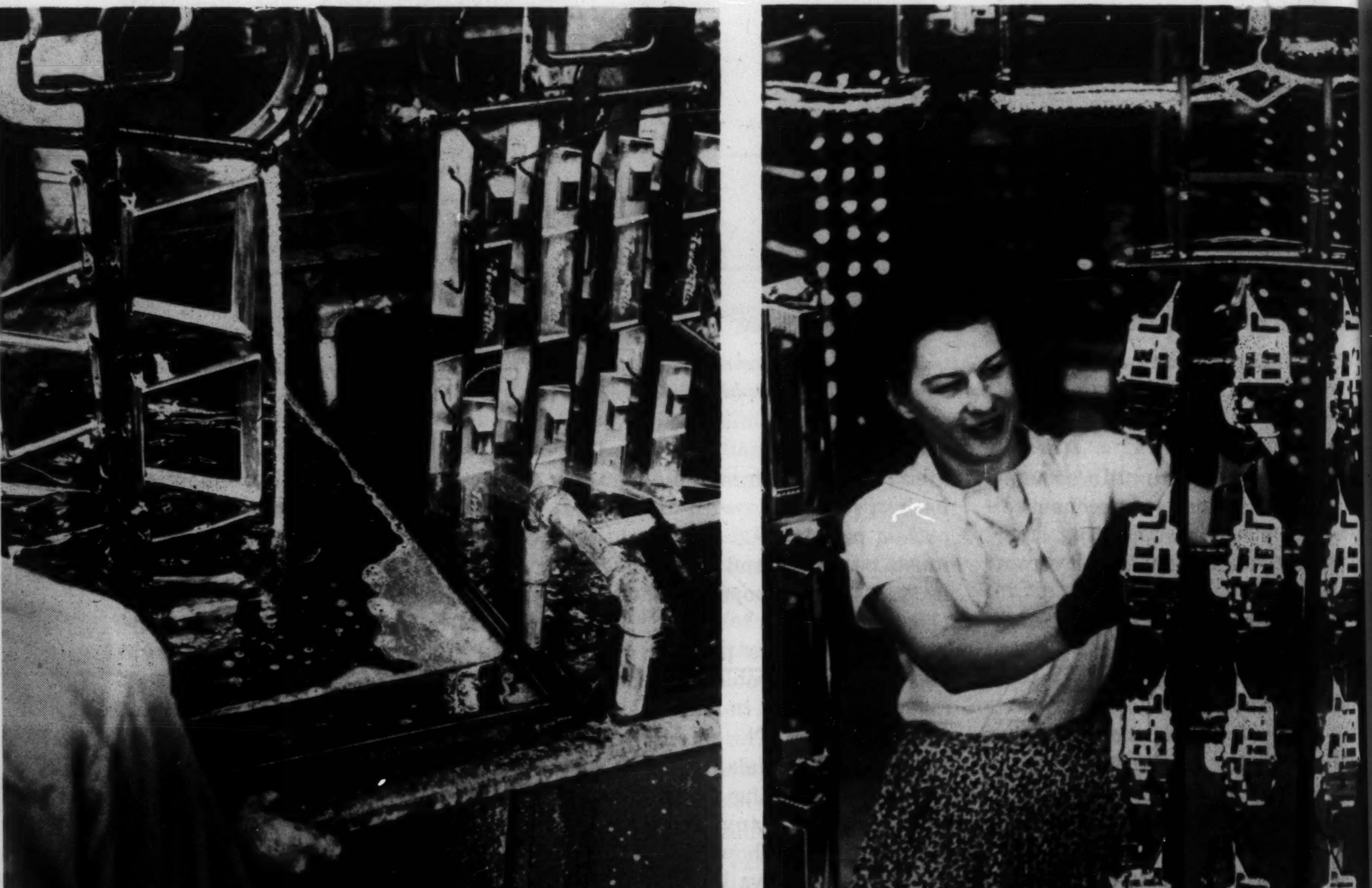
The acid tin bath, with low throwing power, is used to produce heavier deposits at lower cost and higher plating rates than the alkaline bath.

Tin alloys

The tin alloys, such as tin-copper, tin-zinc and tin-copper-zinc, are increasing in importance. Some of these alloys are hard, bright, corrosion resistant and easy to solder. Tin-nickel is also a hard, bright alloy that is attracting interest as a decorative coating.

Zinc

Zinc plates are widely used for sacrificial protection of steel. Zinc will protect the steel as long as it is present, even if there are breaks in the coating. Bright deposits are common and appearance is good for a reasonable period of time. Since zinc corrodes, the life



Lee Silver Service, Inc.

Decorative parts *used on automobiles and appliances are often zinc die castings plated with nickel and chromium. At left, refrigerator parts are rinsed after nickel plating. At right, auto hood crests are unracked after chromium plating and final inspection. Visible at left are parts for automatic washer.*

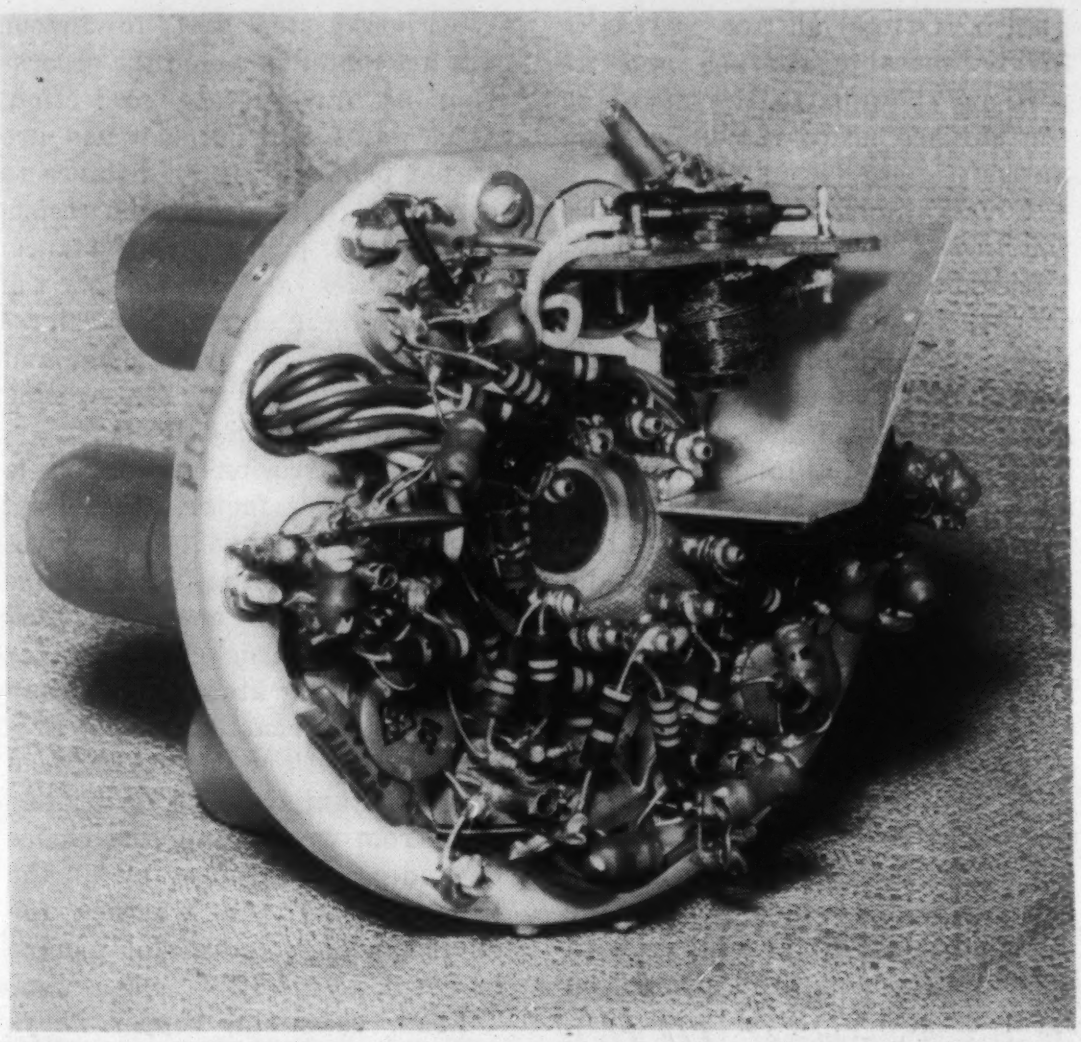
of a coating depends on its thickness. The low cost of zinc makes thick coatings economically feasible.

Plating characteristics of the zinc cyanide bath are good. Zinc is less frequently deposited from an acid bath, which has poor throwing power but is useful where heavy deposits are desired.

Other metals

Proprietary bath formulations are available for plating rhodium, platinum and indium. Rhodium and platinum are used on jewelry. Rhodium is also used as a hard surface with excellent corrosion resistance for special electrical and electronic applications. Indium is deposited on lead and heat treated to form a lead-indium bearing surface.

A decorative "black nickel" deposit can be applied from a nickel bath. The deposit is really nonmetallic and thick deposits will flake off. Corrosion resistance is poor and an intermediate layer is required.



***Electronic assemblies** generally use a number of electroplated coatings. Chassis and hardware are often plated with zinc or cadmium, leads with nickel and lead-tin alloy, and contacts with silver or gold.*

Use of Electroplates—Where and Why

We need only look around us at the products of everyday use to be aware of the large number of applications for electroplated coatings. In order to specify electroplated coatings intelligently, however, it is desirable not only to realize where such coatings are being successfully used today, but also to understand the principal functions of electroplated coatings for such applications. Electroplated coatings are generally used for appearance, for corrosion protection, for wear resistance or lubrication, or for salvage of worn parts. Principal applications for the common types of electroplates are summarized in Table 6.

Appearance

For the majority of applications, electroplated surfaces are primarily decorative. Many millions of parts are plated to cater to public preference for items that are pleasing to the eye. The surfaces produced require no selling, since the public set the standards many years ago.

It is perhaps a little strange but nevertheless true that even parts that are hidden from the public are frequently plated primarily for appearance. A plated part destined to be hidden within a machine is often easier to sell to a manufacturer than an unplated part with poor appearance. Good appearance suggests quality, good housekeeping and pride of manufacture.

Many different electroplated coatings are used where attractive appearance is an important factor. Silver, gold, rhodium, nickel and chromium are particularly suitable for bright, highly reflective surfaces. These coatings are used on such things as pens, pencils, jewelry and various novelties. Chromium over nickel, of course, is used for trim in many applications, such as automobiles, home appliances and windows.

Less highly reflective surfaces are sometimes acceptable or even preferable. Copper and brass electroplates have a warmer, more traditional appearance than chromium. Tin plates have a bright appearance and provide an inexpensive, decorative finish, particularly for small parts. Zinc and cadmium add sales appeal as well as protection to low cost items such as nuts and bolts.

Perhaps the single greatest advantage of electroplated surfaces is that they are commonly accepted standards. Metal trim and metal finishes are so common that we accept them at a glance. Often, all we see is a bright metallic surface and we give no thought to the metal on the surface or to the underlying metal.

For example, we expect to see the brass color common to electrical fixtures, and we are little concerned with the fact that many such parts consist of brass deposits on a steel backing. Chromium and nickel plated bathroom hardware, chromium plated automobile trim (now being challenged by anodized aluminum) and silver plated eating utensils are equally accepted. Plated wall plates for electric switches, drawer pulls, luggage hardware, writing instruments and business machines are also common, though not always preferred.

Corrosion protection

In a great many applications an electroplated surface serves the dual purpose of providing both good appearance and protection from corrosion. Steel will rust, become unsightly and possibly even fail unless its surface is covered with some sort of protective coating.

Although steel parts for indoor use are plated as much for decoration as for surface protection, steel parts for outdoor use are plated primarily for resistance to corrosion. Where corrosion resistance is of primary importance, electroplates are chosen on the basis of their electrochemical relationship to the base metal and their resistance to the specific corrosive environment.

Where corrosion protection is the primary factor, the least expensive coating that gives adequate protection is the one selected. Tin is used for food containers and nickel is used for low cost eating utensils. Lead and lead-tin alloys are used for protection of battery parts. Zinc, lead and cadmium are used for protection from weathering, the choice depending on the base metal, the life expected and whether the environment is industrial, marine or rural.

Lead, cadmium, copper alloys and nickel are used for corrosion resistance in the presence of oil, depending on specific exposure conditions, such as temperature, amount of wear, etc. Silver, chromium, nickel, lead and tin are used to resist specific chemicals, depending on their concentration, temperature and degree of movement. Silver, gold and nickel are used for laboratory equipment. Tin, nickel and silver are used on food processing machinery. Zinc is generally used for resistance to moisture, although cadmium is used in marine atmospheres. Cadmium is also used on home laundry machines.

Low cost

Where low cost is an important factor, electroplated coatings may be desirable for several reasons.

First, some coating metals are inherently low in cost and can be economically applied by electrodeposition. The outstanding example is zinc which offers an attractive appearance plus good protection to steel. It is widely used on nuts, bolts, hardware and low priced tools.

Second, electroplating makes it possible to apply even the more expensive metals in such thin coatings that cost is not excessive. Copper and tin, for example, are

Steel crimping rolls *are chromium plated originally, also chromium plated for salvage.*

Van der Horst Corp. of America

not inexpensive metals but are plated in very thin layers on such low price items as pins and paper clips. Similarly, thin gold plates are often used on inexpensive costume jewelry.

Third, barrel plating makes it possible to finish small parts in large volumes at a very low cost per part. Automatic barrel plating can be used to advantage with both the less expensive coating metals, such as zinc, and more expensive coating metals, such as nickel.

Fourth, many electroplated coatings are available in the form of prefinished sheet and strip. Steel sheet plated with tin, zinc and lead-tin is produced in large quantities and, because of the large scale continuous production process, is quite inexpensive. Sheet and coils of steel, zinc, copper, brass and aluminum with plated coatings of chromium, nickel, copper and brass are also commercially available. Typical applications are lighting fixtures, toys, luggage hardware, trim, eraser disks, emblems, nameplates, battery clips, reflectors, electrical appliances and automotive specialties.

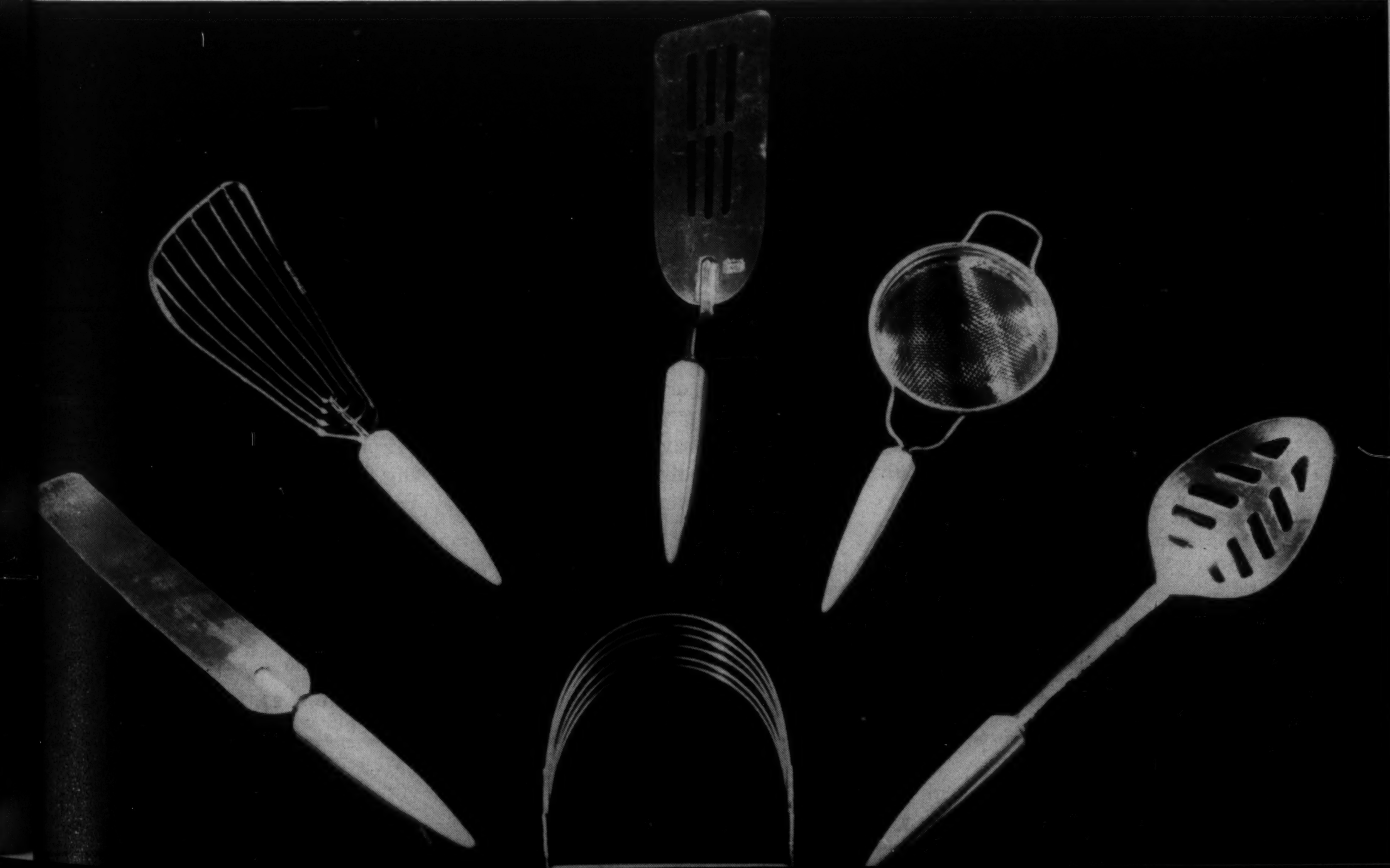
Wear resistance, lubrication

Relatively thin electroplated coatings are used to increase wear resistance, to reduce friction and to provide a lubricating surface. Lead alloy, tin alloy and silver plates are used for sleeve bearings and other applications requiring low friction, nonseizing surfaces. Tin is used as a break-in surface for pistons and bearings. A porous chromium plate that retains lubricating oil has been used for many years on cylinder liners in Diesel engines.

Rhodium is used over silver on electrical contacts subject to heavy wear. Chromium is used on the edges of cutting tools to provide a low friction, wear resistant, nonwelding surface in contact with the chip. Hard nickel and

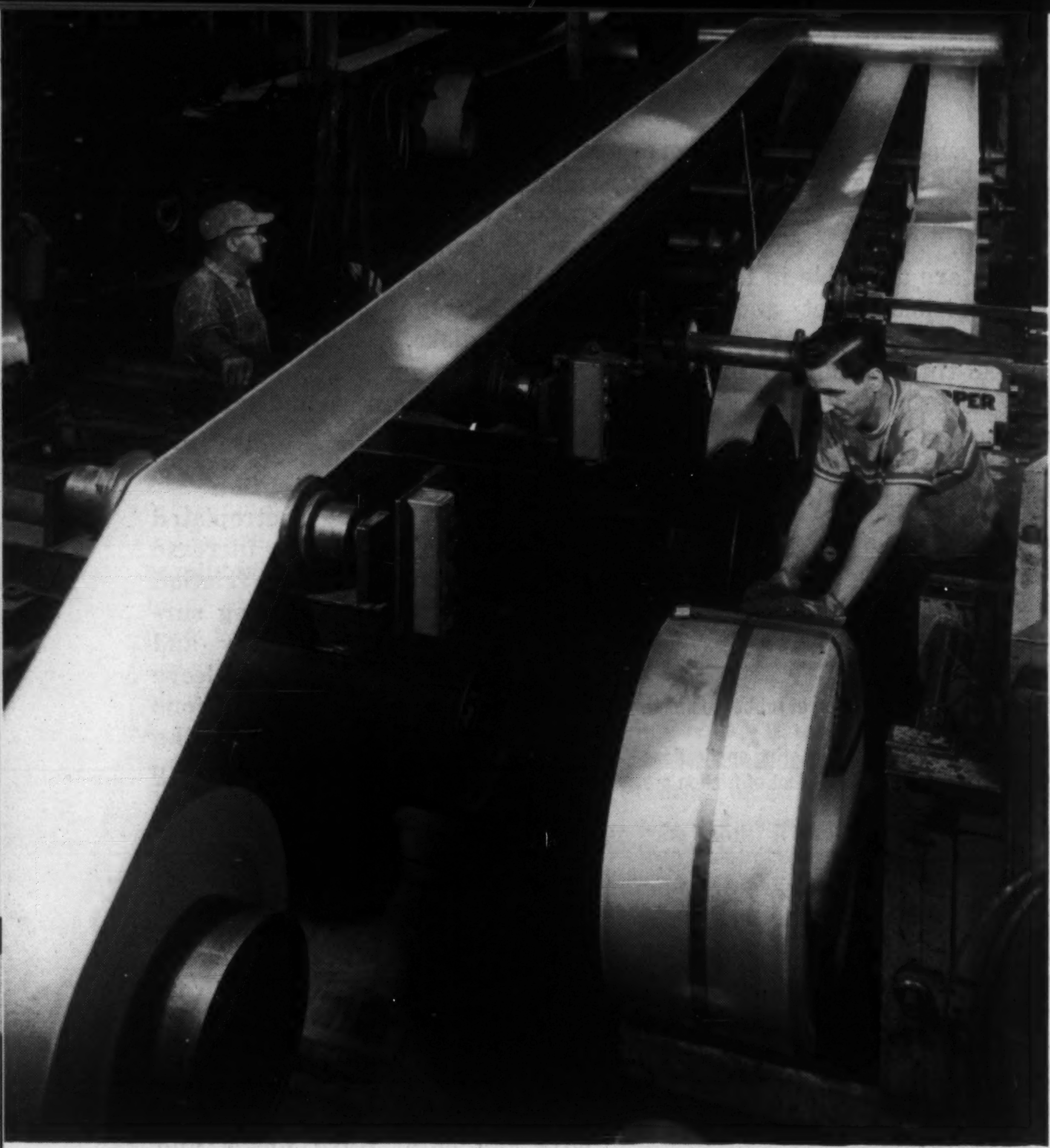
TABLE 6—PRINCIPAL APPLICATIONS FOR COMMON ELECTROPLATES

Brass	Brass or bronze color (lacquered to avoid tarnishing). Adhesion of rubber to metal.
Cadmium	Corrosion protection of steel in salt or moist atmospheres.
Chromium	Decorative, bright, nontarnishing, wear resistant surface. Engineering applications where resistance to wear, corrosion resistance and low coefficient of friction are important.
Copper (cyanide)	Undercoat for other metals to reduce buffing and polishing costs. A "strike" prior to depositing other metals.
Copper (acid)	Electroforming, electrotyping.
Gold	Jewelry. Electrical contacts. Infrared reflectors.
Iron	Electroforming. Build-up prior to plating other metals.
Lead	Storage battery parts, resistance to chemical corrosion.
Nickel	Undercoat for other metals, particularly chromium. Corrosion protection of steel, brass and zinc die castings.
Silver	Decorative finish for tableware and musical instruments. Electrical contacts, high conductivity electrical parts.
Tin	Tin can stock. Nontoxic crorrosion protection in food industries. Parts to be soldered.
Zinc	Low cost protection of iron and steel against atmospheric corrosion.



Kitchenware *is often plated with tin or nickel.*

Hanson-Van Winkle-Munning Co.



Thomas Strip Div., Pittsburgh Steel Co.

***Preplated strip** is available in a variety of coatings and base metals.*

chromium plates are widely used to increase the life of dies, molds and rolls. Soft metals, such as copper and tin, have been used as solid lubricants on parts to be severely drawn or otherwise formed.

Salvage

Parts that have been subjected to severe wear can often be plated with nickel or chromium and reground to proper dimensions at a fraction of the cost of making entirely new parts. Tools, dies and rolls may be replated many times during the course of their useful life. Chromium is used to meet the most severe service conditions, and nickel is used where service conditions are less severe and the lower cost of nickel is important. On a part that has been deeply scratched, gouged or galled, such as a large roll, it is good practice to grind smooth, nickel plate, grind undersize, chromium plate and grind to size. Where a heavy buildup is required, iron is sometimes plated prior to nickel or chromium in order to reduce cost.

In addition to restoring worn surfaces, salvage plating is used to reclaim badly machined parts that would otherwise be scrapped.

Other uses

Electroplated coatings are used for a variety of special purposes in addition to those already discussed. These uses include:

Reflecting surface—Reflectivity is important not only for decorative purposes but also in lamp reflectors and similar applications where the intensity, not the particular hue, of light reflected is most important. Nickel plus chromium is widely used for reflectors.

Bonding surface—Electroplated coatings are sometimes used to improve the bond between the base metal and another material. Good examples are: the use of brass on steel to promote adhesion to rubber in automobile tires; the use of zinc on steel to promote paint adhesion; and the use of a silver strike on steel to improve the adhesion of a subsequent silver plate.

Barrier — Copper and bronze electroplates are used to keep selected areas of steel parts from absorbing carbon or nitrogen during carburizing or nitriding. Of course, an electroplated coating used for corrosion protection that does not provide sacrificial protection to the base metal also functions essentially as a barrier.

Electrical contact surface — Highly conductive precious metals are plated on electrical contacts to provide a combination of tarnish resistance, low contact resistance and solderability.

Surface reproduction—The electrodeposition process is used to produce excellent reproductions of a surface. Electroformed parts and shapes are common. Typical examples are very thin sheets of copper and nickel, tubes, screens, floats and bells for musical instruments. Electroformed molds, long used in the production of phonograph records, are finding increasing use in the production of various plastics products.

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Selection and Applications of Spring Materials

Materials (Commercial Name)	Characteristics and Applications	Available Sizes	Application Temp, F	General Properties
High carbon spring steels are the most commonly used of all spring materials. Try to use these materials in preference to others because they are the least expensive, are readily available, easily worked and most popular.				
Music Wire 0.80–0.95% C (SAE 1085)	Best, toughest and most widely used material for small springs.	Dia 0.005–0.125 in.; some larger sizes to 3/16 in.	Max 250; not suitable for sub-zero service.	Round wire has highest tensile strength of all spring materials; not available with high strenght in square or rectangular sections. Withstands higher stresses under repeated loading than other spring materials.
Oil-Tempered MB Grade 0.60-0.70% C (SAE 1065)	General purpose spring steel used for many types of coil springs where cost of music wire is too great or in sizes larger than obtainable in music wire.	Dia 0.125-0.500 in.; can be obtained in larger or smaller sizes. Square and rectangular sections obtainable in fractional sizes.	Max 350; not suitable for sub-zero service.	Not suitable for shock or impact loading.
Oil-Tempered HB Grade 0.75-0.85% C (SAE 1080)	Same as MB Grade.	Same as MB Grade.	Same as MB Grade.	Higher carbon content than MB provides higher tensile strength to withstand higher operating stresses.
Hard-Drawn MB Grade 0.60-0.70% C (SAE 1065)	Cheapest spring steel commonly used for general purpose springs where cost is most important factor.	Dia 0.031-0.500 in. and some smaller and larger sizes.	Max 250; not suitable for sub-zero service.	Used where long life and accuracy of loads and deflections are not too important.
Hard-Drawn HB Grade 0.75-0.85% C (SAE 1080)	Applications half-way between music wire and oil-tempered wire.	Dia 0.031-0.500 in. and some smaller and larger sizes.		Tensile strengths similar to music wire at half the price.
Hard-Drawn Upholstery Wire 0.40-0.60% C (SAE 1050)	Cheap wire used for wire forms and hooks but rarely for mechanical springs.			Useful where loads are not important and fatigue life is not a factor.
Tool steels—Toolmakers occasionally make a spring from drill rod or alloy tool steel and obtain good results—often however, early breakage occurs due to incorrect heat treatment.				
Drill Rod (oil hardening tool steels)	Expensive but occasionally used for springs in high temperature applications under high stress.	—	—	—
High Speed Tool Steels (18-4-1)	Have been used at temperatures to 775 F with tortional stresses to 70,000 psi.	—	Max 775 —	
Flat high carbon strips—Although several types of thin flat strip are obtainable for specific applications in watches, clocks and certain instruments, only two types are readily available. These compositions are used for over 95% of all applications requiring flat high carbon strip.				
Cold-Rolled Spring Steel Blue Tempered or Annealed 0.70-0.80% C (SAE 1075)	Most popular flat cold rolled spring steel. Widely used for spring clips, flat springs, clock springs, motor, power and spiral springs.	Thicknesses from 0.005 to 0.062 in. and some thinner or thicker sections.	—	Can be hardened and tempered after forming. Hardness Rockwell C42-C46 recommended for springs.
Cold-Rolled Spring Steel Blue Tempered. Clock Steel 0.90-1.05% C (SAE 1095)	Used chiefly in clock and motor springs. Also instrument and flat springs having limited forming requirements.	—	—	Can withstand higher stresses than SAE 1075 used principally in blue tempered condition. Rockwell C47-C51 used for springs.

◄ For more information, Circle No. 517

"RACKING" FOR PERFECTION

Edlund Machinery Co. (Division of Precision Castings Co. Inc.) Cortland, N. Y., specializes in the manufacture of variable-speed drilling and tapping machines. The high-precision work performed by these machines demands that highest quality materials be used, that close tolerances be held and that long service life must be inherent in every working component of every machine.

To conform to these rigid requirements, Edlund makes use of characteristics found in B&W Mechanical Tubing. Purchased in multiple lengths, this tubing is used to make the spindle sleeves which control the up-and-down movement of drills and taps. Operations performed on the tubing include grinding, reaming, turning, tapping and threading. Following these steps, a flat is milled on the tube and a toothed rack is broached on this flat to engage a pinion.

The decision of Edlund to use B&W tubing was based on these findings, among others:

"Better machinability...cuts faster...finer finish ...teeth more durable...always uniform and straight ...superior to other tubing...the end result is a better Edlund product."

At no premium cost, any user of mechanical tubing can have the premium qualities which are built into every foot of B&W tubing. Send for Mr. Tubes, your B&W representative who has all the facts you need. *Or write for Bulletin 340.*

The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W
TUBULAR PRODUCTS DIVISION

TA-5061(M)

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels

For more information, turn to Reader Service Card, Circle No. 499

MATERIALS ENGINEERING FILE FACTS

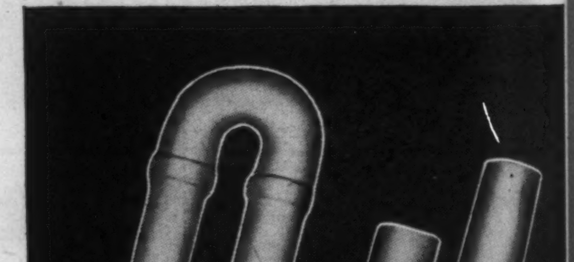
Selection and Applications of Spring Materials (Continued)

Materials (Commercial Name)	Characteristics and Applications	Available Sizes	Application Temp, F	General Properties
Valve springs—Breakage of valve springs in automotive engines, often encountered in the early twenties, is now rarely found. Reduced stress, improved design and better steel have contributed to the solution of the problem.				
High Carbon Valve Spring Wire 0.60-0.70% C (ASTM A230)	Quite expensive. Used for automotive and aircraft engine valve springs.	Dia 0.093-0.250 in. only.	—	Tensile strength between 200,000 and 230,000 psi in all sizes. Made under rigid conditions for uniformity. Especially suited for springs requiring high fatigue properties.
Chromium-Vanadium Valve Spring Wire (ASTM A232)	This special alloy is the highest quality steel wire used for automotive and aircraft valve springs.	All U.S. Steel wire gage sizes; fractional sizes from 0.030 to 0.437 in.	Max 400	Withstands high stresses, shock and impact loading with relatively high fatigue life.
Stainless spring steel uses have increased considerably in recent years. Several new compositions are now available to withstand corrosion. All of these materials can be used for high temperatures up to 550 F, but only the "18-8" compositions should be used at subzero temperatures.				
Type 302	Most popular of stainless spring steels.	Dia 0.005-0.1875 in. also flat strip.	Max 550; suitable for sub-zero service.	Highest tensile strength of stainless spring steels. Slightly magnetic after cold working to produce spring properties. Cannot be hardened by heat treatment.
Type 304	Used as alternate for Type 302 where stresses are not too high.	Same as Type 302.	Same as Type 302.	Better bending properties than Type 302 and slightly lower strength (5%).
Type 316	Aeronautical springs.	Same as Type 302.	Same as Type 302.	Tensile strength about 10-15% lower than Type 302 but slightly better corrosion resistance.
Type 17-7PH	Limited application because of high cost.	—	—	Formed in moderately hard condition and precipitation hardened. Tensile strength nearly equal to music wire.
Type 414	Commonly used in flat cold rolled strip for stampings.	Dia up to 0.1875 in. also flat strip.	Not satisfactory for sub-zero temperatures.	Hard drawn tensile strengths about 15% lower than Type 302. Can be hardened by heat treatment.
Type 420	Best stainless steel for diameters above 0.1875 in. but is used in smaller sizes. 0.057 in. is used for recoil springs in Garand rifles.	—	—	Formed in annealed condition, then hardened and tempered. Has stainless properties in hardened condition.
Type 431	Applications are developing because of high strength.	—	—	High tensile properties by heat treatment followed by cold drawing. In this condition tensile strengths are nearly the same as music wire. Corrosion resistance not equal to Type 302.

(to be continued next month)

← For more information, Circle No. 536

Thermalloy*
radiant tubes
Give Longer Service Life



CENTRIFUGALLY CAST
to insure uniform wall thickness
PRESSURE TESTED
to assure freedom from leakage
X-RAY CONTROLLED
to guarantee soundness

Thermalloy Radiant Tubes assure you of maximum economy and minimum maintenance in your heat-treat operations. Here's why!

Our engineers specify the correct Thermalloy high-heat-resistant alloy for your particular application. Tube sections are centrifugally cast to your specific diameters to insure greater density, finer grain structure and uniform wall thickness.

X-ray technicians control the soundness of tube sections and finished assemblies are pressure tested. As a result, you are assured of *radiant tube assemblies* that are free of leaks . . . that last longer without cracking, warping or sagging.

Whatever your needs in radiant tube assemblies or other heat-treat equipment, call your nearest Electro-Alloys representative. He will show you the operating economy you can realize with Thermalloy castings. Or, write Electro-Alloys Division, 7027 Taylor Street, Elyria, Ohio.

*Registered U. S. Pat. Off.

AMERICAN
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ELECTRO-ALLOYS DIVISION
Elyria, Ohio

For more information, turn to Reader Service Card, Circle No. 456

NEW MATERIALS PREVIEWS

This month

- *U. S. urethane rubber*
- *Foam-in-place polystyrene, other new materials, p 141.*

ypical products *which can be made of urethane rubber include accumulator bladders from 3 cu in. to 10 gal, sheets, craper rings, O-rings, U-cups, gaskets, diaphragms, bellows, shoe heels and lifts, check valves, piston rings, oil seals, ears, and coatings for metal rollers and bearings.*

Urethane Rubber Parts Available in U. S.

■ A diisocyanate polyester-based
lastomer is now commercially
vailable in this country in the
orm of custom molded or cast
arts. The material is said to
ffer unusually high tensile
trength and abrasion resistance,
ood aging characteristics, and
esistance to high ozone concen-
rations, to oil and jet fuels, and
o radioactivity.

Called Disogrin, the elastomer
s expected to find widest use in
ydraulic and fuel handling sys-
ems where sealing and abrasion
re problems. Table 1 indicates
ome typical properties of the
naterial and the range of proper-
ies that can be obtained by alter-
ng the formulation.

The material is being produced
y *Greer Industries, Inc.*, New
ork International Airport, Ja-
aica 30, N. Y., under a Mobay
hemical Co. license and a tech-

TABLE 1—TYPICAL PROPERTIES OF DISOGRIN COMPOUNDS[a]

Compound number	13	15	17	22	23	24
Durometer Hardness, Shore A	80	75	90	85	88	90
Resilience, %	50	60	33	40	37	37
Tensile strength, psi	7230	5910	5470	5700	6300	6900
Elongation, %	680	750	540	630	690	670
Abrasion[b]	35	31	33	22	26	26
Color	Amber	Blue	Amber	Amber	Amber	Amber

[a] Specific gravity: approx. 1.25.

[b] Values compare with 65 for Buna-N.

TABLE 2—OIL AND FUEL RESISTANCE—A COMPARISON WITH OTHER ELASTOMERS[a]

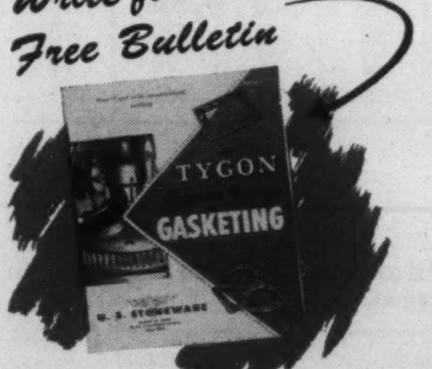
Oil or Fuel	Disogrin		Buna-N		Neoprene	
	Durometer Change	Volume Change, %	Durometer Change	Volume Change, %	Durometer Change	Volume Change, %
DTE heavy-med. Oil	−3	0	+7	−8	−9	+2
Pydraul	−56	+48	−92	+73	−78	+42
JP-4	0	+3	−6	+12	−20	+19
Water	−16	0	−3	+6	−5	0
Mil-O-5606	−3	0	−6	+25	−25	+32

[a] All tests run 7 da at 200 F.

TYGON GASKETING

Tough • Non-Aging • Chemical-Resistant

Write for this Free Bulletin



Bulletin G-520R describes Tygon Gasketing. It will be mailed promptly on request. Address: Plastics & Synthetics Division, The U. S. Stoneware Co., Akron 9, O.

One sure answer to tough gasketing problems is the versatile corrosion-resistant TYGON family of plastic compounds. For TYGON not only resists acids, alkalies, oils, greases and water — but is strong, resilient, abrasion-resistant and light in weight. TYGON is also impermeable, non-contaminating and non-oxidizing. TYGON can be used for virtually any gasketing job in chemical processing and general industrial equipment — wherever positive, enduring seals or separators are required. For food and beverage uses, special non-toxic compounds are also available.

For service as gasketing, TYGON is made in a number of standard compounds, translucent or glossy black, which offer a range of physical, electrical, and chemical properties for almost any application.

TYGON gaskets can be die-cut from calendered or press-polished sheets (1/64″ to 1/2″ thick); can be molded in practically any size or shape; or can be extruded as tubing, solid cord, or channel in continuous lengths.

OTHER TYGON PLASTICS: Tygon is likewise made in the form of flexible tubing, hot and cold applied protective coatings, protective sheet linings for acid tanks, and in molded form.

139-E

PLASTICS AND SYNTHETICS DIVISION

U. S. STONEWARE

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ical assistance agreement with Germany's Carl Freudenberg, producer of a similar elastomer (Vulkollan). Diisocyanate - polyester elastomers were first developed in Germany and are now widely used in that country. Several companies in this country have been working with isocyanate base elastomers on a developmental scale.

Two basic types of Disogrin parts are currently being manufactured: 1) compression and injection molded, and 2) liquid cast. The liquid casting method permits lower cost forming of a variety of shapes not practical by molding.

The elastomer can be bonded to metals by special processes. Best adhesion is obtained by molding or casting directly against metal. Where necessary, Disogrin parts can be reinforced with fabric.

Other properties of the urethane elastomer:

1. It is flame-retardant.
2. It is said to have excellent aging properties.
3. Its resistance to oils having less than 90% aromatics is claimed to be extremely good. Data on resistance to oils, fuels and other solvents are given in Tables 2, 3 and 4.
4. Sunlight causes darkening of the material though its properties remain unaffected.

TABLE 3—RESISTANCE TO OILS AND FUELS (TYPICAL VALUES)

Oil or Fuel	Durometer Change	Volume Change, %
70 hr at 68 F		
ASTM No. 1	0	+0.3
ASTM No 2	−5	+13.0
ASTM No. 3	+1	+5.0
Mobil Arctic Oil	−5	+0.3
Esso No. 90 Lube	−13	+1.1
Mil-L-7808-B	0	+1.0
JP-4	0	+2.0
70 hr at 300 F		
ASTM No. 1	−35	−2.0
Mil-L-7808-B	−20	+3.0
100 hr at 212 F		
ASTM No. 3	+5	+1.0

TABLE 4—RESISTANCE TO OTHER SOLVENTS[a]

Solvent	Durometer Change	Volume Change, %
Toluene	−6	+58.0
Chloroform	−25	+410.0
Carbon tetrachloride	−5	+18.5
Chlorobenzene	−10	+110.0
Isopropanol	−3	+4.5
Ethylene glycol	−1	0
Phenol	[b]	+245.0
Acetic acid	−15	+149.0
Aniline oil	−30	+339.0
Nitrobenzene	−15	+173.0
Benzaldehyde	−20	+212.0
Methyl ethyl ketone	−10	+103.0
Ethyl acetate	−9	+99.0
Liquid ammonia	−10	+3.0
Freon 12	−2	+1.0
Benzene	−10	+98.0

[a] All tests run 100 hr at 140 F. [b] Breaks easily.

OTHER NEW MATERIALS PRODUCTS

New Source for Foam-in-Place Polystyrene

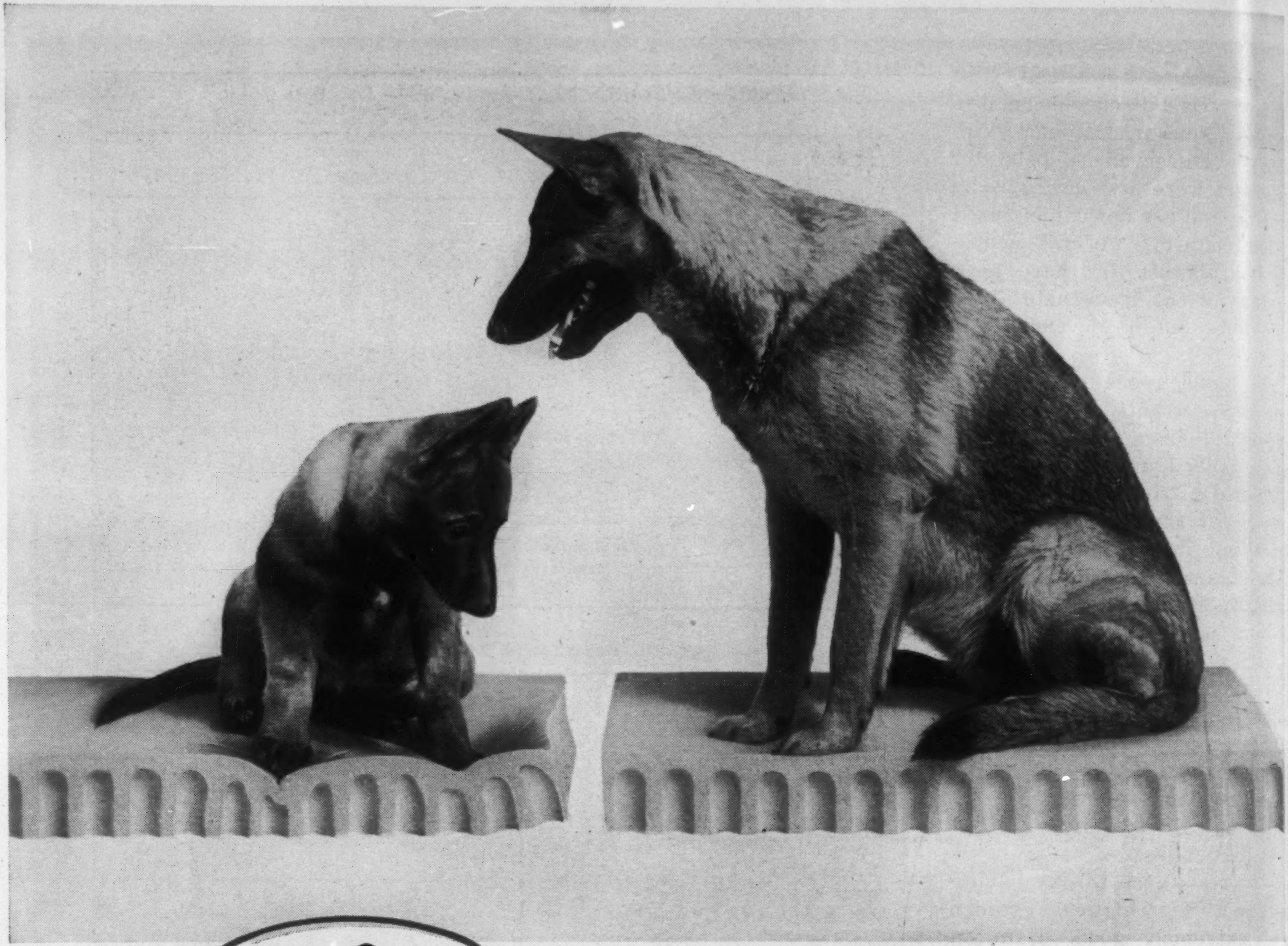
■ An expandable polystyrene plastic, which can be foamed in place to fill any shaped cavity, will be produced by *Uni-Crest Div. of United Cork Co.*, Kearny, N.J. The material, similar to Kopper's Dylite, is expected to be commercially available sometime this summer.

Called Uni-Crest, it is being produced under license by the BASF (Badische Anilin & Soda-Fabrik A.G.) process developed in Europe. Uni-Crest Div. plans to produce the material in standard slab, brick or block form in lengths up to 12 ft, widths up to 4 ft and thicknesses up to 8 in. It will also be supplied as expandable beads, or as parts molded to customer specifications.

The finished product is made from beads (or partially expanded beads) which expand and fuse on heating to form a homogeneous white product of closed cell structure. Density ranges from 1 to 20 lb per cu ft. The finished shape is said to have a smooth tough

TYPICAL PROPERTIES OF UNI-CREST FOAM
(at 1.24 lb per cu ft density)

Specific gravity	0.02
Comp str, psi	16-20
Ten str, psi	44-46
Water absorp in 24 hr, % by vol	0.5
Water vapor trans, gm/sq m/in./24 hr	4.25
Therm cond, Btu/hr/sq ft/F/in.	0.23-0.25



Now! VINYL foam ...so versatile, it can be varied to meet your needs!

A totally new foam product with exceptional durability, economy and, most of all, *versatility*—became possible through the development of the vinyl plastisol resin. (Exon 654 in the Firestone line of vinyls.)

Vinylfoam is produced by the Elastomer process, using Exon 654 as the base resin.

Molded in cored or slab form, it can be modified at no extra cost to be as soft or as firm as you need, as light or as heavy, as thick or as thin, as resilient or as "dead."

It can be electronically heat-sealed without affecting any of its properties.

Exon 654 makes Vinylfoam exceptionally resistant to abrasion, corrosion, flame, aging, moisture, tearing and chemical action. With maximum dimensional stability, it resists oxidation, hardening and drying out.

It can be embossed, die cut, split or skived; molded directly onto textiles and most synthetics, and onto vinyl sheeting or film in continuous lengths. Mutual surface impregnation forms a homogeneous bond.

Vinylfoam gives products in almost every field new comfort, safety, durability. Vinyl's economy makes them cost less, sell easily.

because it's made of

Firestone

EXON

VERSATILE VINYL RESINS

engineered answers to industry's needs

Firestone Plastics Company supplies the plastisol resin for Vinylfoam... does not make the finished foam itself.

For complete information or technical service on the entire line of Exon resins, call or write today:

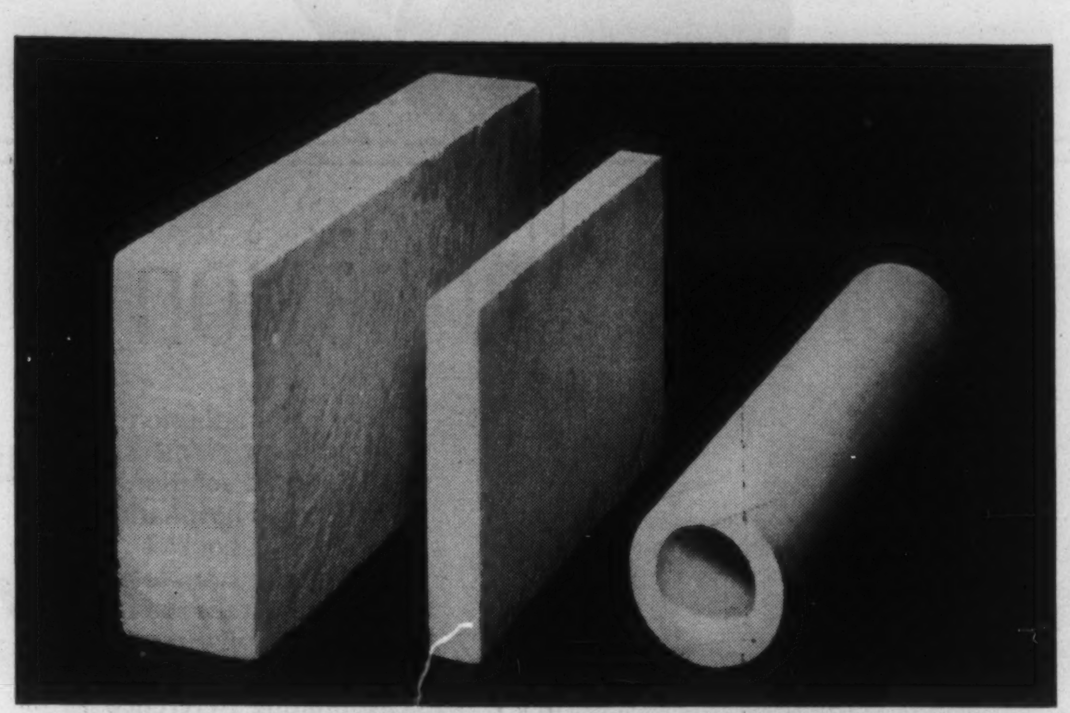
CHEMICAL SALES DIVISION

FIRESTONE PLASTICS CO., DEPT. 63-J, POTTSTOWN, PA. • A DIVISION OF THE FIRESTONE TIRE & RUBBER CO.

For more information, turn to Reader Service Card, Circle No. 425

skin that can be used without coating or can be coated with conventional paints and finishes, provided they contain no solvents for styrene. It is odorless, nontoxic, nonfriable, dimensionally stable and impervious to parasitic insects, vermin and fungi. It can be cut with a knife, hot wire or ordinary wood working tools.

Low temperature insulation is a primary application for the material. It can be used in cold storage or freezing rooms, or for insulating cold lines. It also should find application in flotation equipment, and its low dielectric constant and loss factor would indicate applications in the electrical and electronic fields.



Slab, block or tube *offer good possibilities for low temperature insulation.*

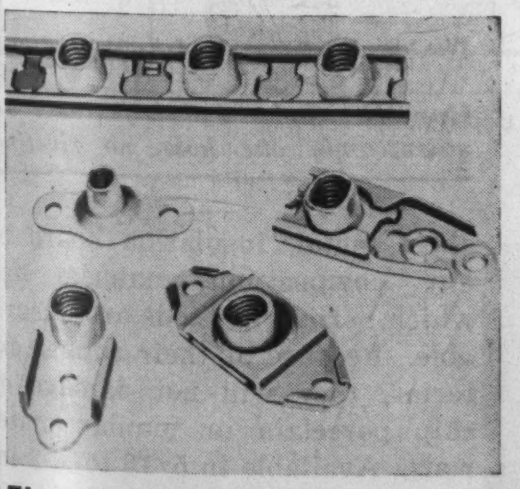
New Fasteners—Light, Strong, Versatile

■ Recent fastener developments include lightweight locknuts for temperatures to 800 F, a new aircraft rivet, and slip-squeeze nuts.

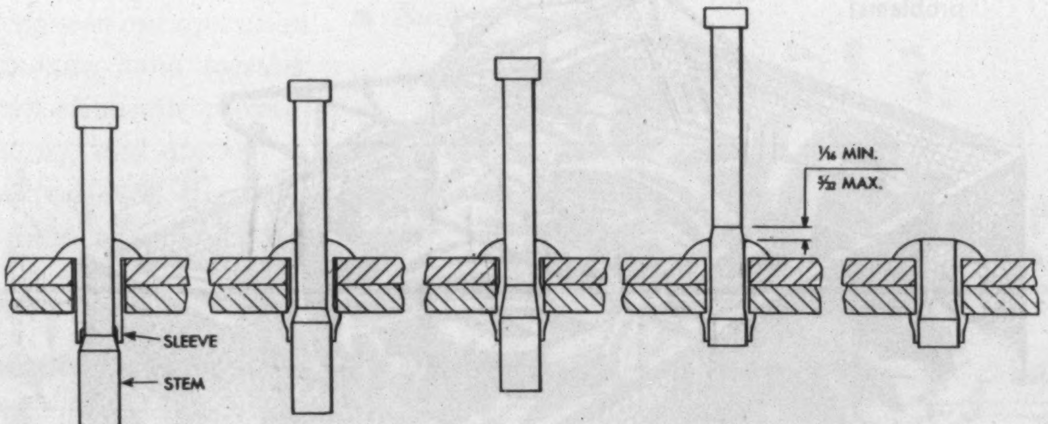
1. Lightweight steel nut

Lightweight stainless steel anchor and gang channel locknuts for use at temperatures to 800 F and where nonmagnetic fasteners are needed are available from *Elastic Stop Nut Corp. of America,* 2330 Vauxhall Rd., Union, N.J. The 70LHA401 and 70LHG41 series are claimed to be the lightest available nuts qualified to meet these conditions. Savings in weight over ESNA's earlier designs range from 16 to 63%.

Configurations in the 70LHA line include one- and two-lug anchor or plate nut shapes. One floating nut body in the series has a 0.030 in. minimum radial float and another design offers multiple floating nuts installed in a strip of stainless steel channel. All designs are for blind mounted applications. Nut retainers and channels are of Type 321 stainless steel. Thread sizes in the anchor line for each configuration are 6-32, 8-32, 10-32 and ¼-28. These sizes, with the exception of 6-32, are also available in the gang channel units.



These locknuts *are nonmagnetic, can be used up to 800 F.*



How it works *See accompanying description of new aircraft rivet.*

2. Aircraft rivet

A new fastener for the aircraft industry has been developed by *Townsend Co., Cherry Rivet Div.,* Santa Ana, Calif. Designated the 700 Rivet, it is claimed to provide a wide grip range, positive hole fill, high clinch and uniform stem retention. It also permits 100% inspection.

The rivet, as shown in the accompanying drawings, consists of a two-piece assembly: a sleeve portion and a stem portion. As the large diameter on the stem is pulled into the sleeve, the shank is expanded and draws the sheets together with a high clinching action (second drawing). The center drawing shows how the large stem portion is necked or drawn down to a diameter just small enough to permit it to pass through the sleeve. The stem continues to pass through the sleeve until its shoulder projects about

poor paint adhesion?

If poor paint adhesion is your problem, chances are you'll find the solution in the Turcoat Phosphating Manual. This booklet describes the complete Turcoat line, tells the full story of phosphating and includes a valuable "Phosphating Reference Chart," which quickly gives the answer to any paint adhesion problem.

If you are interested in permanent paint adhesion, write today for the Turcoat Manual. There is no cost or obligation.

FREE MANUAL
shows how phosphating will solve your problems!

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Manufactured in Canada by B. W. Deane & Co., Montreal

You will be assured of a *permanent paint seal,* simply by using Turcoat as a bond for organic finishing.

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Please send me a copy of the Turcoat Manual without cost or obligation.

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Title____________________ MM

For more information, turn to Reader Service Card, Circle No. 462

OTHER NEW MATERIALS PRODUCTS

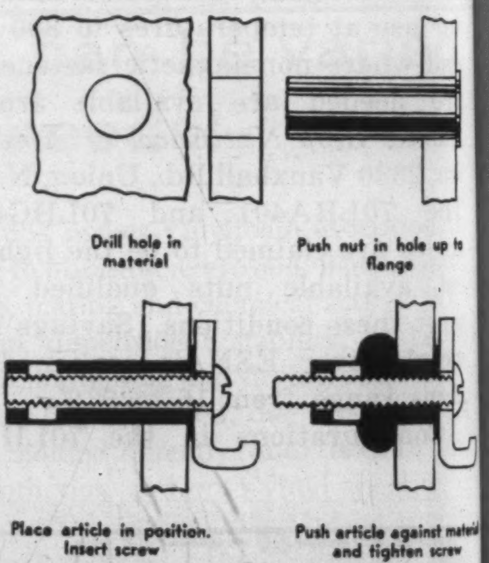
1/16 in. above the rivet head, a shown in the fourth drawing This feature permits positive visual inspection. The pull is stopped at a predetermined point without breaking the stem. Length of pull is controlled by interchangeable sleeves in the gun pulling head

The rivet is available in both countersunk and universal head styles.

3. Blind fastener

The Well-Nut is a rubber bushing in one end of which is bonded a threaded hex brass nut. The opposite end has a flange. Made by *Rockwell Products Corp.,* 14 Central Ave., Newark 3, N. J. these nuts are claimed not to shake loose under extreme vibration stresses. They provide an airtight and watertight seal and hold where panels are too thin to be tapped for a screw.

Well-Nuts can be used for making attachments to porcelain, thin plastics, glass, laminated wood

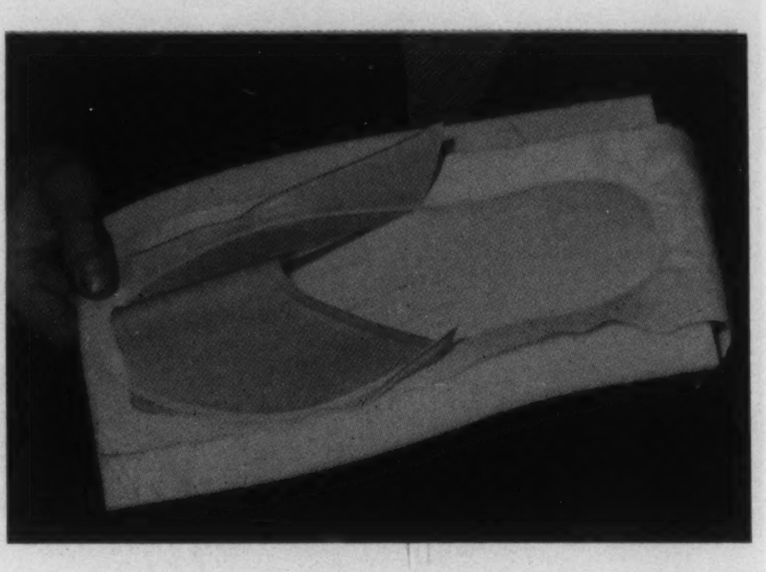

Drill hole in material
Push nut in hole up to flange
Place article in position. Insert screw
Push article against materi and tighten screw

How it works *Panel fastener requires only one hole, no riveting.*

sheet metal, insulation board or any composition material for which normal methods are unsuitable. Because of their rubber exterior, they will not damage or chip porcelain or similar materials. Available in 5/16 to 1/2 in. dia and 6-32, 10-32 and ¼-20 thread sizes, these nuts can be assembled from one side.

(continued on p 146)

idea page | *A new lift for your product, new products for your markets*



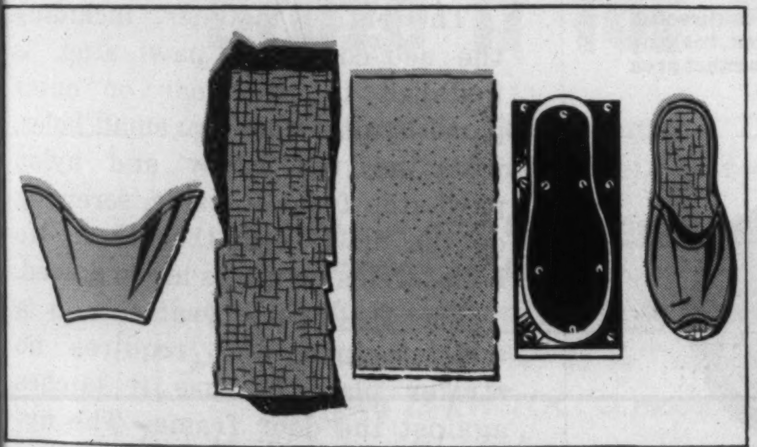
One-step manufacturing with heat-sealed vinyl foam

■ *For a wide range of products, you can combine virtually all manufacturing operations into a single processing step by using vinyl foam and new heat-sealing methods.*

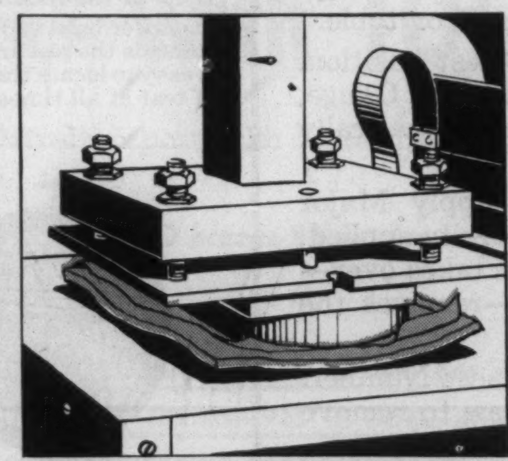
Vinyl foam heat-seals to itself, to vinyl film, to coated fabrics, Saran, and many other synthetic or natural fabrics. The heat-sealing—in one operation—can form, mold, and permanently bond together several component parts. You can eliminate production steps such as shaping, sewing, and gluing . . . and you can use a "tear-seal" die to eliminate preliminary cutting and the final trim finishing. Vinyl foam can give you:

- *Built-in cushioning*
- *Wear and abrasion resistance*
- *Unlimited choice of colors*
- *Resistance to soaps, oils, acids, alkalis*
- *Fire resistance*

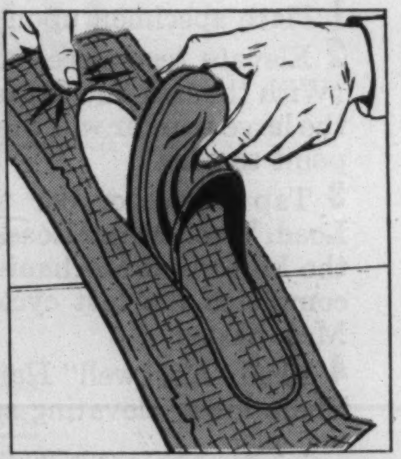
Three-piece lounging slipper is fabricated in one processing operation



Start with vinyl film top, vinyl foam insole, embossed vinyl film outersole.



Shape, mold, and permanently bond component parts in a "tear-seal" die with a single heat-sealing operation.



The "tear-seal" die allows the slipper to be removed by simple hand-tearing.

MONSANTO

Where Creative Chemistry Works Wonders for You

You can also fabricate vinyl foam by die-cutting, splitting, skiving, molding, stitching, hot-wire shaping or forming. Monsanto manufactures plasticizers and vinyl resins for vinyl foam . . . but does not produce or distribute the finished formulations. For sources of vinyl foam sheets or slabs, write MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, Department ID-3, St. Louis 1, Mo.

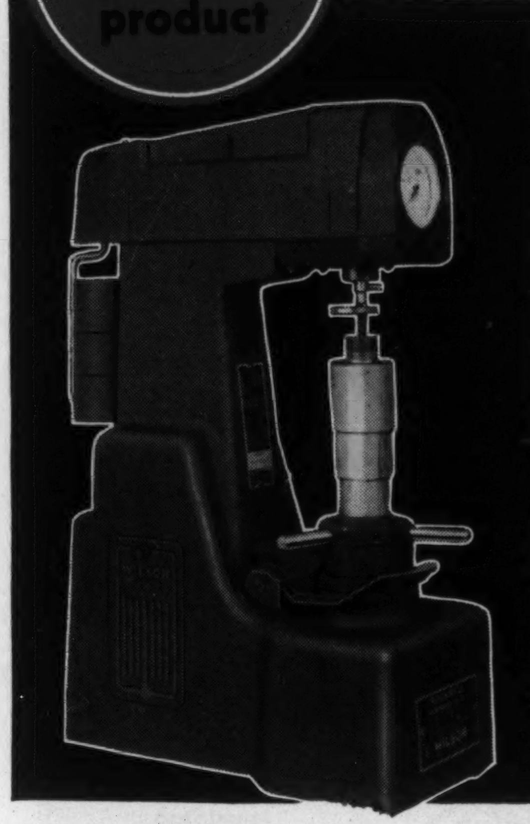
Saran: Reg. trademark of Dow Chemical Co.

For more information, turn to Reader Service Card, Circle No. 430

an ACCO product

Wilson "Rockwell"* Hardness Testers

Tests with INCREASED SPEED... Accurately



Y Model Motorized Hardness Tester

Requires fewer operating steps... Because

IT'S MOTORIZED

• Here is the motorized operating procedure made possible by the new WILSON "Rockwell" Y Model Motorized Hardness Tester—

1 Place specimen upon anvil or table.

2 Elevate test piece into test position. (With the new Set-O-Matic Dial Gauge, the large pointer will then automatically point to zero.)

3 Tap depressor bar to apply Major Load. When Major Load is fully applied, the Motorized Mechanism takes over—completes the test cycle—removes the Major Load.

4 Read "Rockwell" Hardness Number. Then, lower elevating screw to remove test piece.

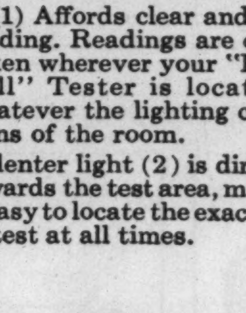
For complete information about the WILSON Y Model, or any others of the complete line of WILSON "Rockwell" Hardness Testers, write or call today. A WILSON hardness testing expert is available to consult on your specific requirement.

*Trade mark registered

Illuminated Dial Gauge

(1) Affords clear and easy reading. Readings are easily taken wherever your "Rockwell" Tester is located—whatever the lighting conditions of the room.

Indenter light (2) is directed towards the test area, making it easy to locate the exact area of test at all times.



Set-O-Matic Dial Gauge

The Set-O-Matic Dial Gauge increases the accuracy of the test, makes the test cycle shorter and increases the number of readings obtainable within a definite period of time.

ACCO

Wilson Mechanical Instrument Division
AMERICAN CHAIN & CABLE
230-E Park Avenue, New York 17, N. Y.

for Better Value

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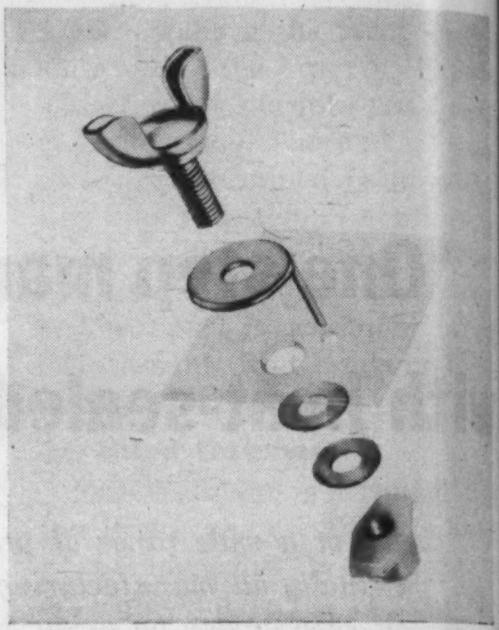
OTHER NEW MATERIALS PRODUCTS



Panel latch *for small doors requires no bolts, welds, rivets.*

4. Adjustable panel latch

A fastener for small doors on electronic equipment and instruments is available from *Southco Div., South Chester Corp.*, 200 Industrial Highway, Lester, Pa. Called the Southco Adjustable Latch, it can be used on material ranging from the thinnest sheets to panels of 0.15-in. total thickness.

The entire fastener, including the self-contained pawl stop, is installed in the door or outer panel by punching two small holes, inserting the screw and nylon pawl stop from one side, screwing on the pawl from the other. No bolts, welds or rivets are required.

The fastener operates with a quarter turn and requires no striker plate because it latches against the door frame. The nylon pawl is said to offer good wearing qualities and to operate more smoothly than metal against a metal frame.

5. Nylon self-locking insert

The Nylok self-locking insert has been added as an optional feature of precision socket head screws and aircraft bolts made by *Standard Pressed Steel Co.*, Jenkintown, Pa. The insert eliminates the need for other locking devices such as lock washers, adhesives

Braze it for 4¢ with TOCCO*

Willey's Carbide Tool Company, Detroit, reports the following benefits from TOCCO *Induction Brazing* of tool tips:

1. ***Large lathe tools: 8 times as fast. TOCCO brazes 85 per hour; former method 80 per day.***
2. ***Cost cut from 58¢ to 4¢ for each large tool.***
3. ***Small tools (3/4" to 1/4" square): TOCCO brazes 250 to 400 per hour.***
4. ***Two 15-KW TOCCO machines paid for themselves in three months.***

Mail coupon for information on many other brazing applications where TOCCO saves important time and money.

THE OHIO CRANKSHAFT COMPANY

TOCCO

JUST PUSH A BUTTON

*Trade Mark Reg. U. S. Pat. Off.

Mail Coupon Today

NEW FREE BULLETIN

THE OHIO CRANKSHAFT CO.
Dept. T-7, Cleveland 5, Ohio

Please send copy of "Tool Tipping with TOCCO."

Name____________________

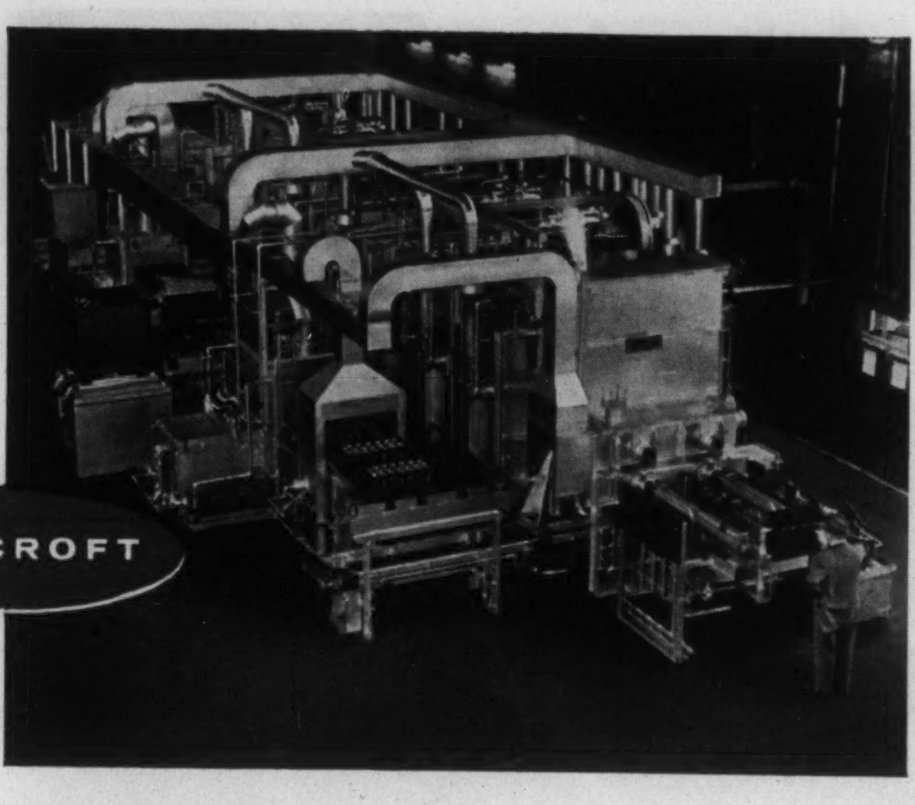
Position____________________

Company____________________

Address____________________

City__________Zone_____State______

***For more information, turn to Reader Service Card, Circle No. 470**



BLAZING
THE
HEAT
TREAT
TRAIL—
WITH
HOLCROFT

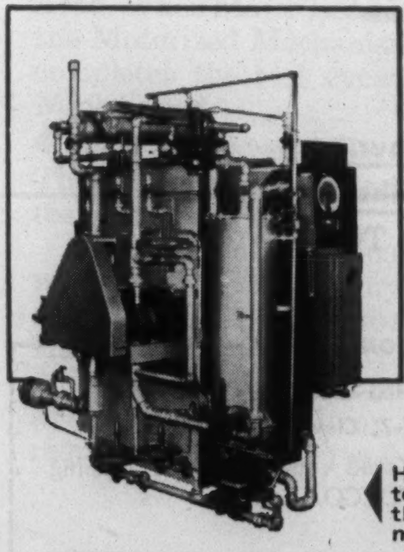
LET'S TALK
CONTROLLED
ATMOSPHERES

Holcroft has pegged many of its research activities to the problems of controlled atmosphere heat treating. As a result, Holcroft has blazed the trail for industry.

Controlled atmospheres protect the stock while it is being treated and help produce the desired finish to the parts. Scale and decarburization are eliminated. Stock in the furnace chamber is surrounded by a gas atmosphere which excludes all air and products of combustion.

Basic gas generator patents go back to 1883. However, the first real use and understanding of fundamental equilibrium constants—now in general use in all gas atmosphere work—was by Holcroft in 1934. Dew point cups and equilibrium curves were furnished customers at that time. Today, Holcroft's new Lo-Dew generator (750, 1200 and 2400 cfh) provides *rated capacities* at low dew points.

Advances like these are typical of the scope of Holcroft activities—proof that you can get right answers without prejudice. Insist upon a Holcroft quotation as your first step when you have a heat treat problem. *You'll save!*



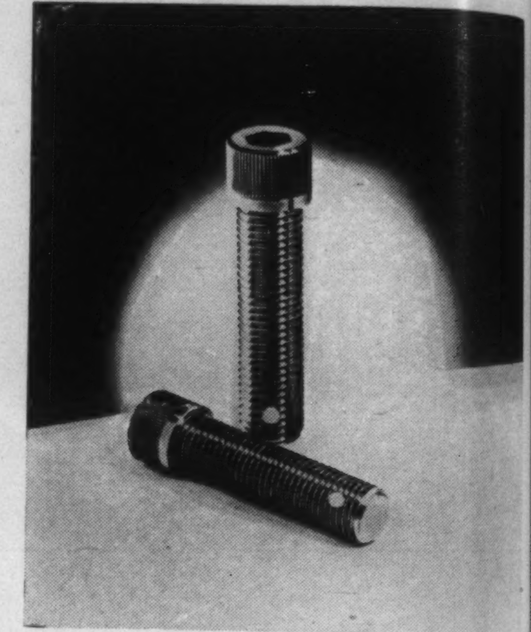
Holcroft's new gas generator designed to produce gas atmospheres between the limits of perfect combustion and modified "302".

HOLCROFT AND COMPANY
BUILT BY HOLCROFT & COMPANY DETROIT • MICH
6545 EPWORTH BOULEVARD • DETROIT 10, MICHIGAN
PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

CHICAGO, ILL. • CLEVELAND, OHIO • DARIEN, CONN. • HOUSTON, TEXAS • LOS ANGELES, CALIF. • PHILADELPHIA, PA.
CANADA: Walker Metal Products, Ltd., Windsor, Ontario

For more information, turn to Reader Serivce Card, Circle No. 528

OTHER NEW MATERIALS PRODUCTS



***Nylon pellets** eliminate need for lock washers, adhesives.*

and wired heads.

The Nylok process makes use of the resilient properties of nylon, which are retained through repeated use at temperatures from −70 to 300 F. A nylon pellet is inserted in a hole drilled part way through the threaded portion of the bolt. When the bolt is installed in a tapped hole or a standard nut, the exposed portion of the nylon pellet is compressed between the mating threads. In an attempt to retain its original shape, the nylon forces the threads together under pressure. This pressure increases the friction between the metal surfaces and resists the tendency of the bolt to loosen in service in vibrating machinery, vehicles and appliances.

6. Slip-squeeze nut

A slip-squeeze nut developed at *Convair Div., General Dynamics Corp.,* San Diego, Calif., is reported to be saving thousands of man-hours in the construction of plaster models and mockups.

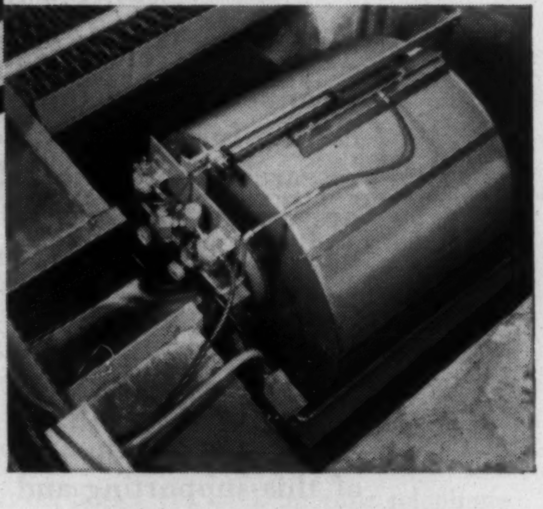
The rod shown in the accompanying drawing is used to hold templates in models while plaster is applied. Wherever a rod passes through the template, a nut is required on each side. Nuts were formerly placed in position by gripping one end of the threaded

the MURRAY WAY MODEL 10 FILTER

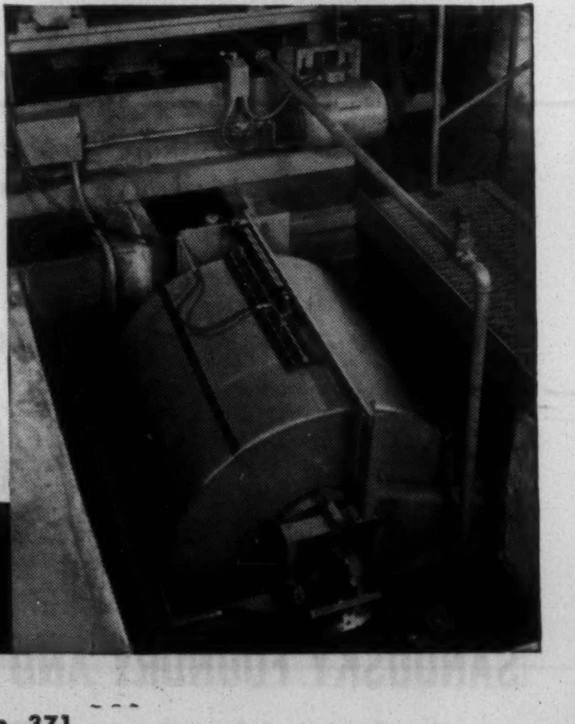
THE AUTOMATIC INDUSTRIAL FILTER THAT RECLAIMS YOUR PRODUCTION DOLLARS

MURRAY-WAY CORP.
BIRMINGHAM

Contaminated coolant enters Model 10 directly from source.



Standard Model 10 with 200 mesh screen removing abrasive grindings from 55 viscous coolant oil in belt grinding operation.



AUTOMATIC—The Murray-Way Model 10 Industrial Filter automatically rotates fresh filtering area into position while simultaneously ejecting the contaminant.

SELF-CLEANING—The permanent filter screen, made in eight sections and screw mounted, is kept clean by the air knife thus giving maximum filtration at all times.

ECONOMICAL—Elimination of costly throw-away media saves you money.

COMPACT—The Murray-Way Model 10 gives you unusually large filtering capacity in proportion to area occupied.

AMAZINGLY ADAPTABLE—The Murray-Way Model 10 Filter may be used as an individual machine unit or as a central filtering station for many units. Capacity may be increased by adding filters in tandem separately or in the same tank.

LARGE SCREEN SELECTION—We can supply filtering screen material and size of screen opening in monel, stainless steel, brass or bronze to meet your requirements.

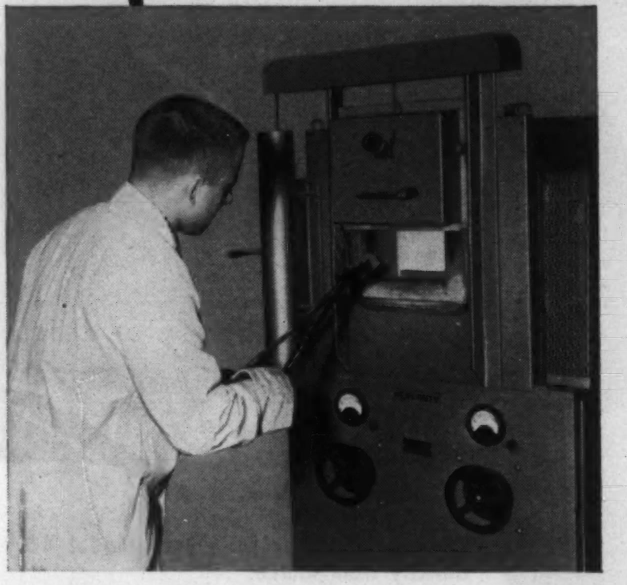
For Complete Technical Details—Write For Bulletin F-5301

MURRAY WAY

THE MURRAY-WAY CORP.
POST OFFICE RACK 180 • BIRMINGHAM, MICH.
Automatic Polishing, Buffing, Grinding, Filtering Equipment

For more information, turn to Reader Service Card, Circle No. 371

Research Results Speak Louder than Words . . .



CHIEF SANDUSKY

FERROUS AND NON-FERROUS CENTRIFUGALLY CAST SLEEVES, ROLLS, LINERS, TUBES, RETORTS, CHUTES, RINGS, BUSHINGS, BEARINGS, ETC.

The success of a centrifugal casting is often determined long before the metal is melted and the casting formed. At Chief Sandusky, it starts in the research laboratories where experienced technicians are continually searching to improve existing methods and develop new ones to meet your specialized needs.

Each casting is then quality controlled through every step of the production process. The result of this supporting and preceding control is a finer, closer grained product which resists heat, corrosion, and abrasion.

Whatever your needs in ferrous and non-ferrous centrifugal castings—or in the way of technical aid or information, call on Chief Sandusky . . . continual leader in its field, continually improving its service to you.

C. M. Lovsted & Co., Seattle, Wash. • Tynes Bros., Birmingham Ala. • Cordes Bros., San Francisco and Wilmington, Calif.

Chief SANDUSKY CENTRIFUGAL CASTINGS

FERROUS AND NON-FERROUS

SANDUSKY FOUNDRY AND MACHINE CO., Sandusky, Ohio

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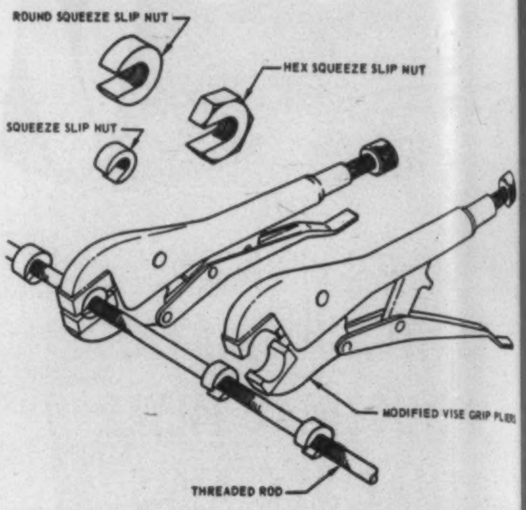
OTHER NEW MATERIALS PRODUCTS



Above-*Unique nut saves time making mockups and plaster models.* **Below**-*Templates aligned with aid of slip-squeeze nuts.*

rod in a drill motor, holding the nuts firmly and revolving the rod.

Slip-squeeze nuts can be slipped into position on the rod and squeezed tight in one operation. The pliers shown in the drawing are a pair of reworked vise grips that were used as a temporary tool for nut installation.

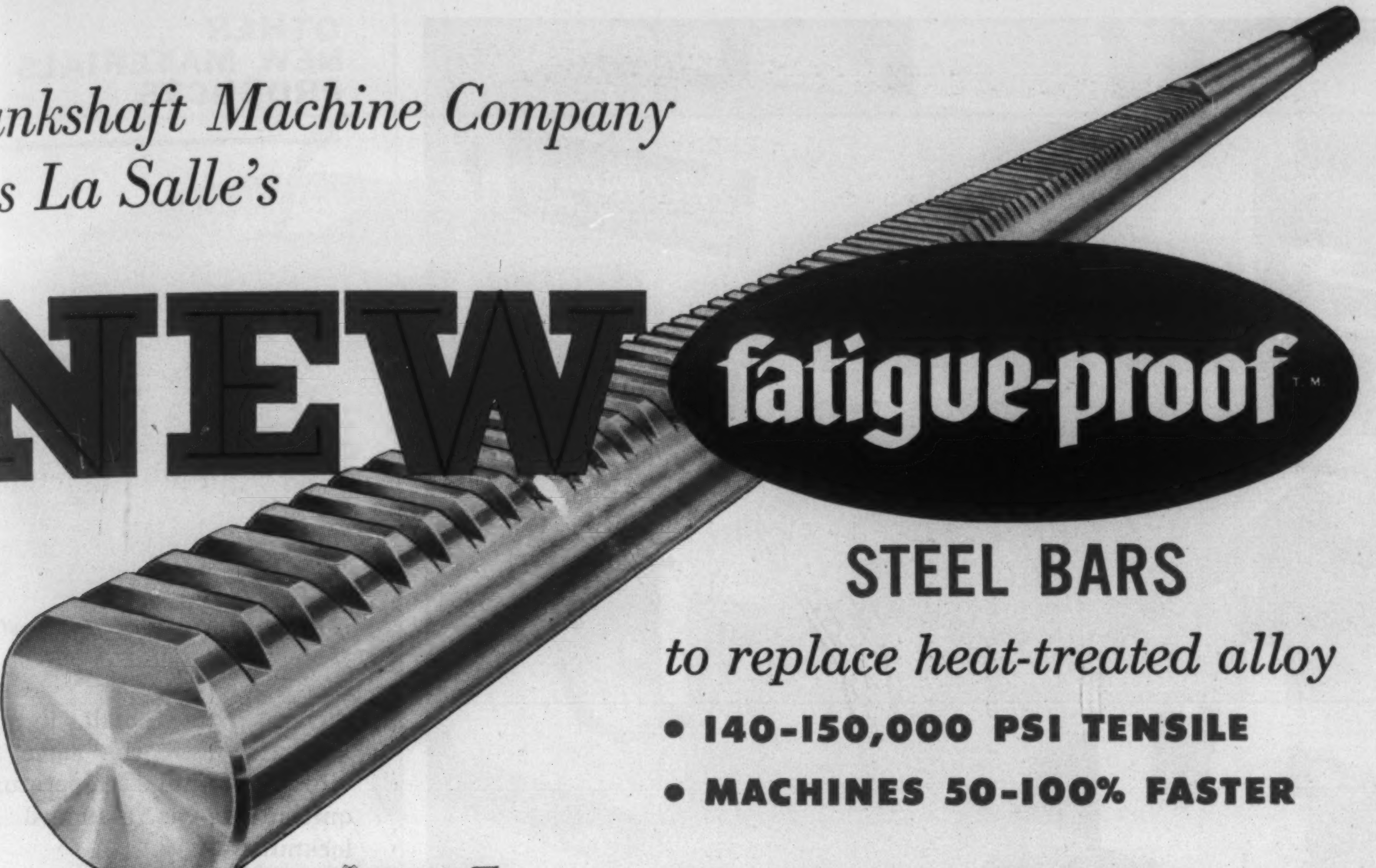
Slip-squeeze nuts can be produced with any perimeter and thread size. The nuts used on ¼-20 rods are made with 5/16-20 thread and a ¼-in. slot. They are squeezed down to the ¼-20 size with the special pliers.

7. Miniature locknut

A line of miniature self-locking anchor nuts has been developed by *Elastic Stop Nut Corp. of America,* Dept. 169, 2330 Vauxhall Rd., Union, N.J. Called Space

Crankshaft Machine Company uses La Salle's

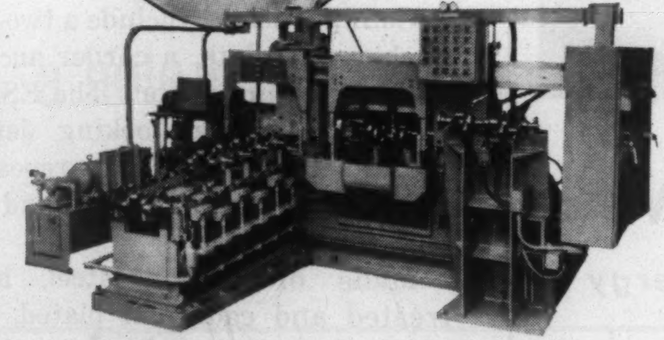
NEW fatigue-proof™



STEEL BARS

to replace heat-treated alloy

- **140-150,000 PSI TENSILE**
- **MACHINES 50-100% FASTER**



FATIGUE-PROOF is specified in this automated turning machine manufactured by Crankshaft Machine Company, Jackson, Michigan.

This $60,000 machine uses FATIGUE-PROOF for a vital part. The rack that actuates the loading mechanism formerly was heat-treated alloy and is now FATIGUE-PROOF.

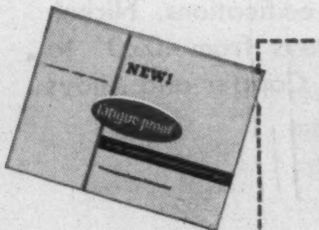
This is an automatic crankshaft turning machine that operates in automotive production lines. It must run dependably. The engine line can't wait for machine repairs.

The rack itself is intricate and machining it was a problem. FATIGUE-PROOF solved that, and it did so at no risk to the machine!

If you are producing parts requiring tensile strengths in the 140,000 to 150,000 p.s.i. range . . if you are interested in a steel bar that has this strength without heat treating . . if you want to trim production costs with a bar that machines faster (25% faster than annealed alloys, 50% to 100% faster than heat-treated alloys) . . if you want to eliminate the cost and inconvenience of heat treating, we invite you to send us a blueprint or detailed description of your application or, better yet, pick up your telephone and call your nearest La Salle Sales Engineer.

TEST FATIGUE-PROOF! If it appears that FATIGUE-PROOF can help improve the quality of your product or cut your production costs, your La Salle Sales Engineer will be glad to furnish you with a sample bar for testing in your own plant.

NEWLY PUBLISHED!
Ask for your copy of this 20-page booklet which gives detailed information on the remarkable new FATIGUE-PROOF . . 29 pictures, tables, charts.



LA SALLE STEEL CO.
1418 150th Street
Hammond, Indiana

Please send me your "FATIGUE-PROOF" Bulletin.

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Title____________________
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Address____________________
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***La Salle* STEEL CO.**
1418 150TH STREET, HAMMOND, INDIANA

Manufacturers of America's Most Complete Line of Quality Cold-Finished Steel Bars

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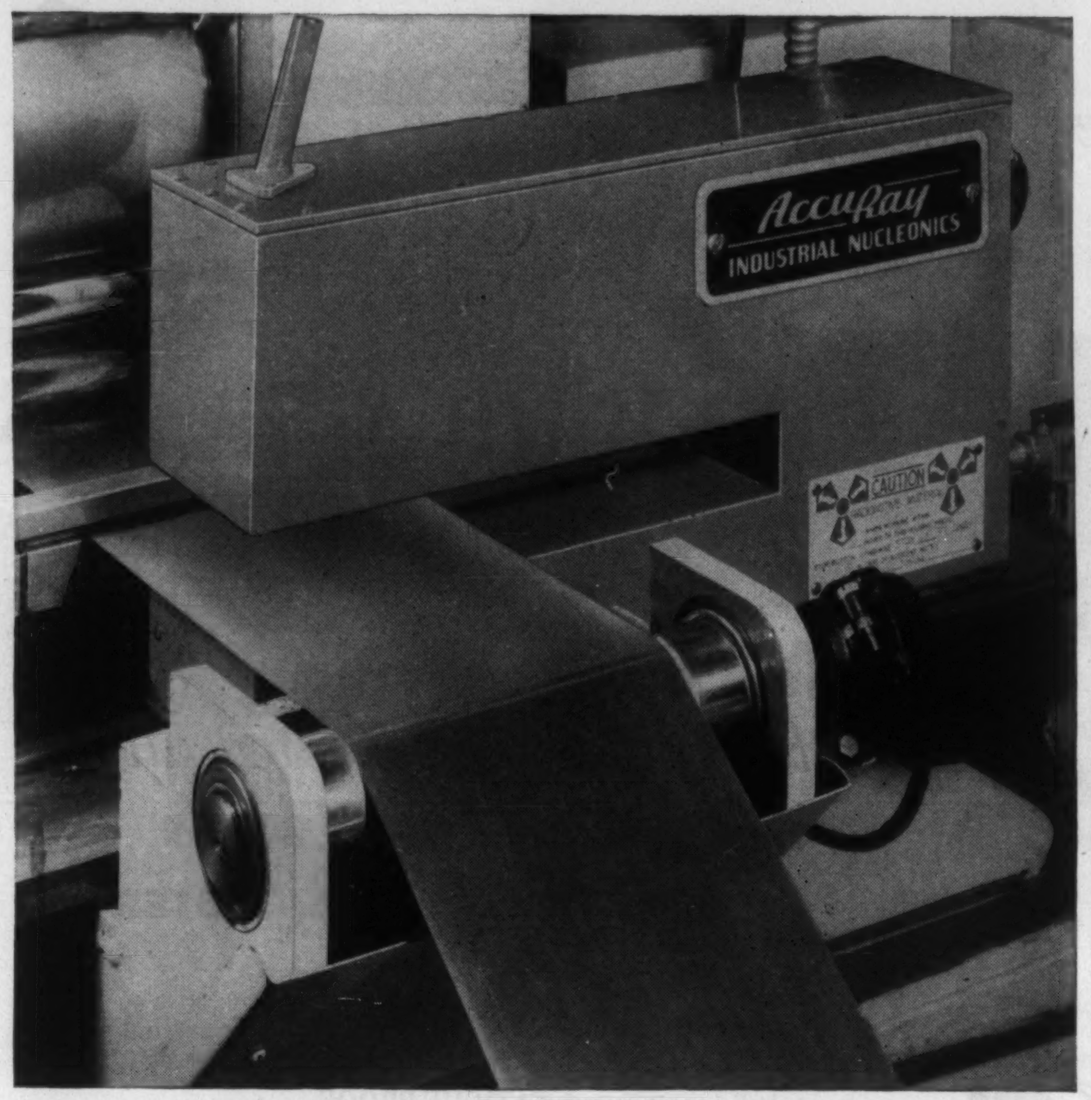
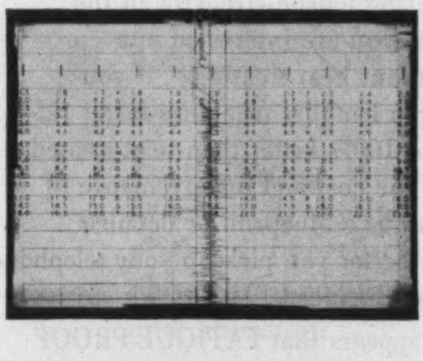


UNIFORM AS THE ATOM

Somers Thin Strip now Gauged by Nuclear Energy



Actual recording of clad steel being rolled to .0065″ within a tolerance of ±.0002″; virtually all the metal is within ±.0001″ (between the heavy vertical lines).

To meet the increasing demands of electronics and other industries for *uniform* closer tolerances, Somers Brass has taken advantage of one of the latest developments in the electronic field by installing the first Accu-Ray gauges in the non-ferrous industry. These units make it possible to check and control thickness from edge to edge throughout each coil to a degree of accuracy never before known.

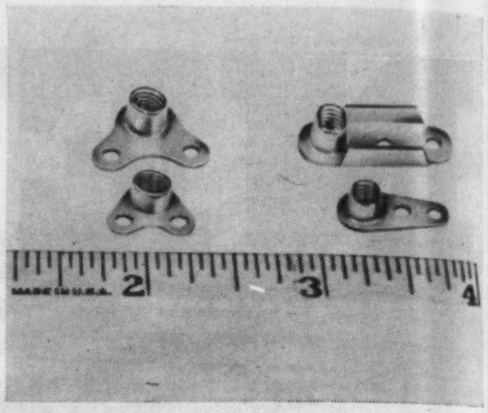
Accu-Ray gauging is typical of the modern methods Somers combines with engineering experience to provide thin strip metal to your most rigid specifications. Nickel, Monel, and Nickel Alloys from .020″ to .00075″. Brass, Bronze, Copper and Alloys from .010″ to .00075″.

For Exacting Standards only

Somers THIN STRIP

SOMERS BRASS COMPANY, INC., 108 BALDWIN AVE., WATERBURY, CONNECTICUT

For more information, turn to Reader Service Card, Circle No. 413



***Miniature nuts** are contrasted with standard sizes in top row.*

Savers, these small, lightweight locknuts meet the same tensile, vibration and temperature requirements as standard AN366 locknuts.

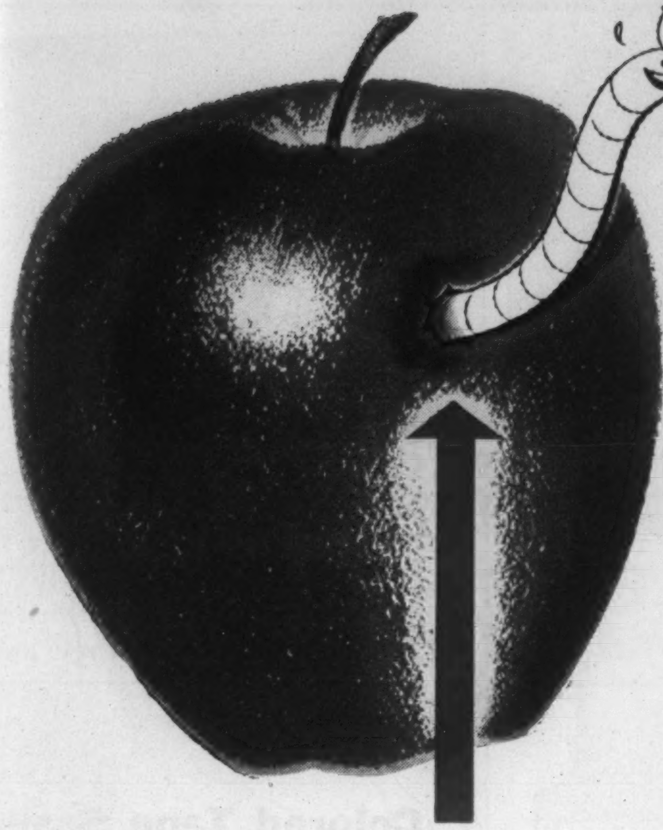
Configurations include a two-lug anchor nut plate, a corner anchor and a one-lug anchor. The ESNA offset crown, self-locking device is said to assure safe, repeated reuse during maintenance and repair.

Made of carbon steel, heat treated and cadmium plated, the anchor nuts weigh about one third as much as standard AN366 locknuts. They meet requirements of AN-N-10 at temperatures up to 500 F. The three configurations are available in 6-32, 8-32, 10-32 and ¼-28 sizes.

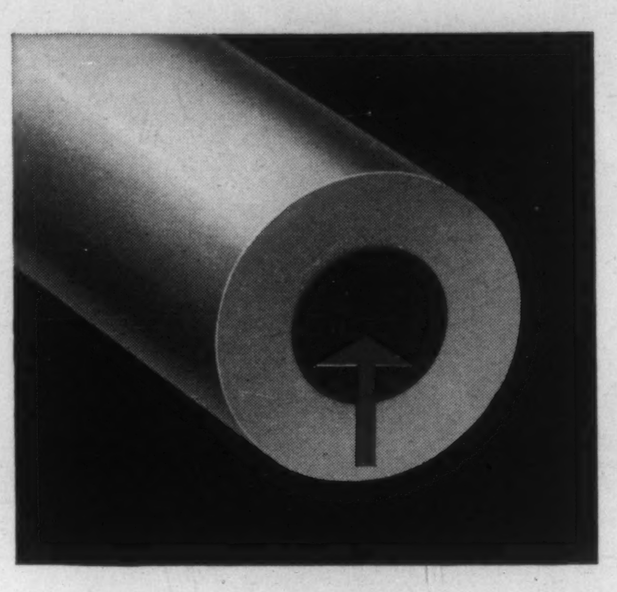
Magnet Wire Coating for Solderable Wire

A magnet wire insulation material designed primarily for use on solderable wire has been developed by *Shawinigan Resins Corp.*, Springfield 2, Mass. The material is based on a combination of Formvar, a polyvinyl formal resin, and urethane.

Formvar-urethane is reported to give good coatings with respect to solderability at low temperatures, resistance to thermoplastic flow, low extractible content and resistance to softening by refrigerant Freon 22. In place of the usual phenolic modifying resin,



a hole here makes waste…



a hole here saves waste

Crucible Hollow Tool Steels save waste — time and money — whenever you need ring-shaped parts or tools with a center hole. For the hole is in the piece when you get it! You eliminate drilling, boring, rough-facing operations — save machine capacity for productive work.

And you can get Crucible Hollow Tool Steels in *any* of our famous tool steel grades . . . in bar lengths or saw cut to your individual requirements. They are made in practically any combination of O.D. and I.D. sizes. What's more, delivery is *immediate* with Crucible's popular KETOS oil-hardening, SANDERSON water-hardening, AIRDI 150 high-carbon high-chromium, AIRKOOL air-hardening, and NU DIE V hot work tool steel grades from warehouse stocks.

Next time you have an application with a center hole, let your Crucible representative show you how these hollow tool steel bars can save you money and time. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

For more information, turn to Reader Service Card, Circle No. 458

"ESCO SPUNCAST® SAVED US 30%

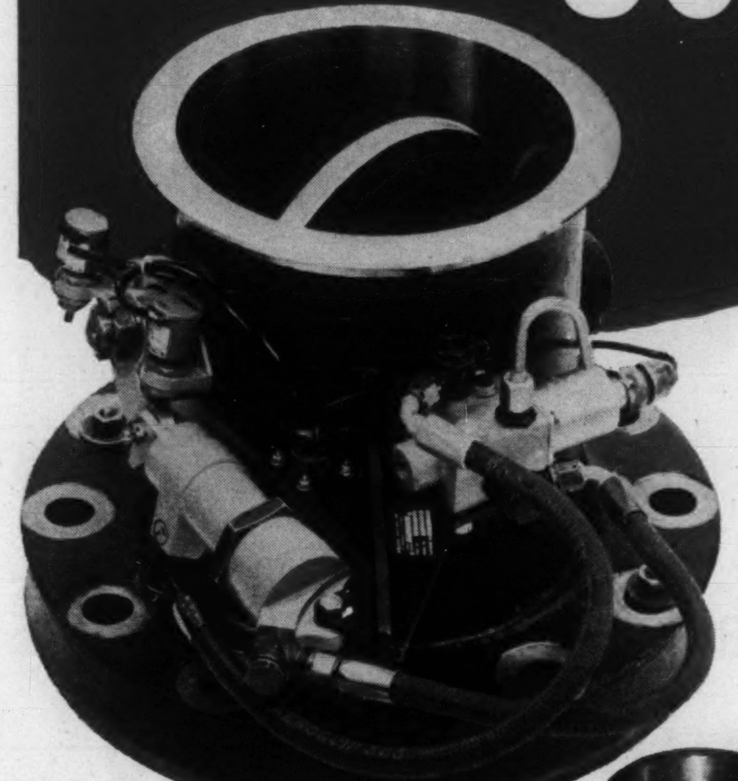
...in the cost of producing guided missile components"

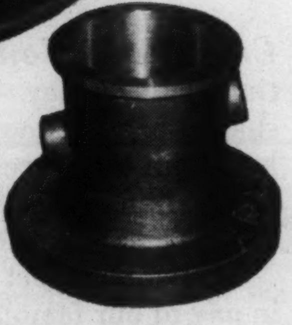
"Heavy butterfly valve bodies of AISI type 304 had previously been fabricated, a time and money consuming operation. Costs had to be cut, yet government specifications had to be maintained. Then we discussed our problem with an *ESCO* Engineer.

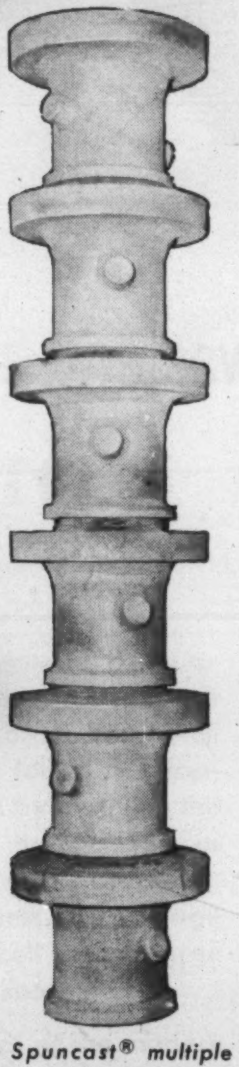
"Today, by taking advantage of *ESCO* multiple-unit centrifugal casting technique (SPUNCAST®) we are able to effect an overall saving in time and material amounting to 30% of our previous costs," says top engineer of Interstate Engineering Corporation, leading missile component manufacturer at El Segundo, California.

Whether your problem is one of heat, corrosion, impact, abrasion or alloy availability, the *ESCO* Engineering staff will help you plan for greater savings in time, material and money.

WRITE FOR FREE BOOKLET







ESCO Spuncast® multiple casting "stick" technique produces six butterfly valve bodies at one time. After parting from the "stick" each valve body weighs approximately 180 pounds as cast.

ELECTRIC
STEEL FOUNDRY
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Eugene, Oregon
Salt Lake City, Utah
Honolulu, Hawaii

In Canada, *ESCO* Limited
Vancouver, B. C., and
Toronto, Ontario

For more information, turn to Reader Service Card, Circle No. 482

OTHER NEW MATERIALS PRODUCTS

Formvar-urethanes employ Mondur-S, an isocyanate derivative manufactured by Mobay Chemical Co., St. Louis, Mo.

Research on Formvar wire enamels shows that Formvar-urethane coatings equal or excel Formvar-phenolic coatings in electrical properties and resistance to heat and water. The new combination is said to resemble the accepted Formvar-phenolic resin enamel in viscosity, solids content, stability during storage and uniformity of coating.

Colored Tape Seals Polyethylene Bags

A colored self-sticking tape for use with automatic bag closure equipment has been developed by *Permacel Tape Corp.*, New Brunswick, N. J. Designated Permacel 742, it is a combination of a pressure sensitive, rubber based, stain resistant adhesive on a colored, impregnated crepe paper backing.

Designed for high speed produce packaging machines, the tape has an average adhesion of 15 oz per in., a tensile strength of 23 lb per in. and 12% elongation. High adhesion assures safe bag closures and the crepe paper assures good conformance to irregular surfaces. The tape is available in dark red, dark green, white, light green, blue or yellow.

Epoxy Pastes Serve as Sealants, Fillers

Seven epoxy pastes available from *Furane Plastics, Inc.*, 4516 Brazil St., Los Angeles 39, have a wide variety of uses. Designated Epocast 150 to 156, they contain no volatile matter and have negligible shrinkage. After setting or hardening, following the addition of a catalyst or hardener, they may be machined, sanded or drilled. The pastes will resist immersion in ethylene gly-

Enjay Butyl—*today's fabulous rubber* gives new life to backyard wading pools

Enjay Butyl brings long life and performance strength to the sensational new Bil-O-Matic®, rubberized fabric wading pool manufactured by the Bilnor Corporation. With its resistance to aging, sunlight, tear and impact damage, the pool manufactured with Enjay Butyl gives outstanding performance. Unlike other pools that cracked and leaked after exposure to sunlight, these *new* pools retain their durability under even the toughest conditions of wear, stress, and weather. The Enjay Butyl label on the carton assures the customer of exceptional quality.

Extremely versatile, Enjay Butyl has led to improved product performance in a wide variety of fields. This amazing, low-cost rubber is *immediately available* in non-staining grades for white and light-colored applications. To find out where Enjay Butyl can *cut costs* and *improve your product,* contact the Enjay Company. Complete laboratory facilities, fully staffed by trained technicians, are at your service.

ENJAY
BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY

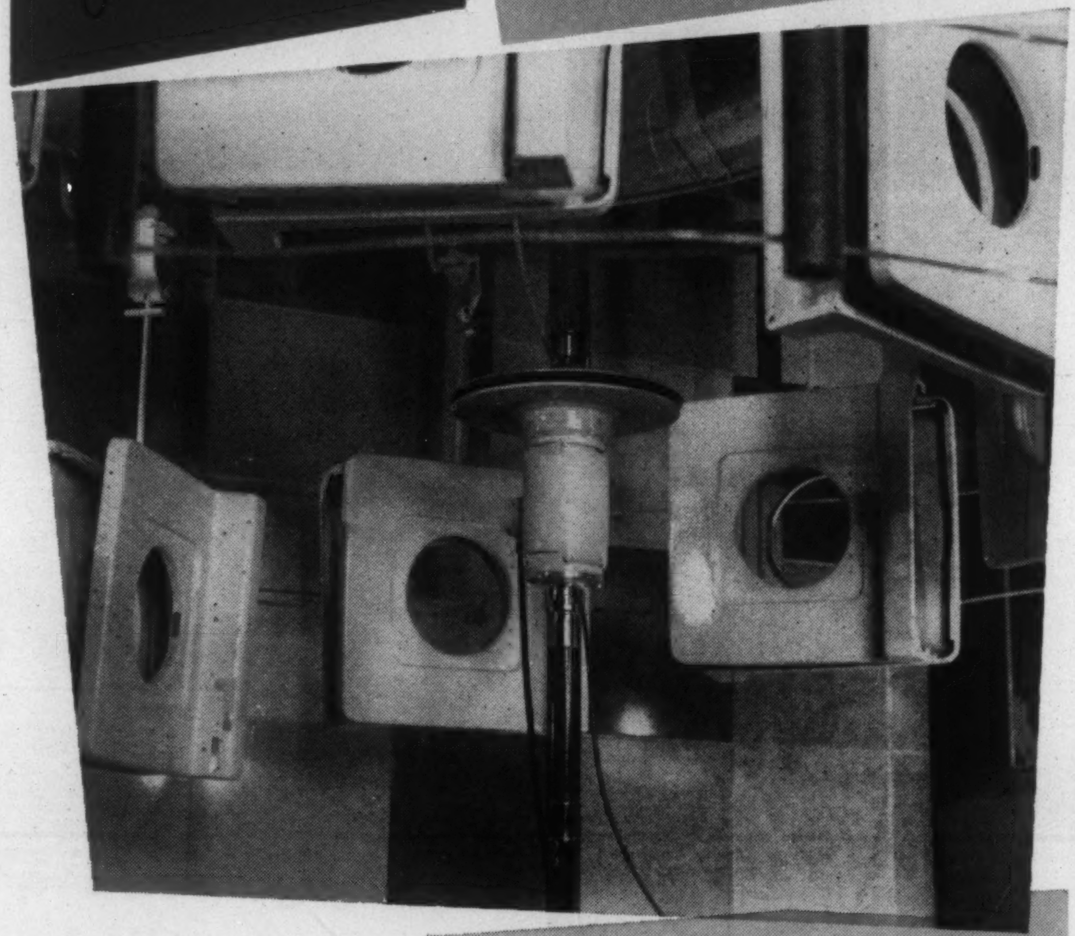
Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.
Other offices: Akron • Boston • Chicago • Los Angeles • Tulsa

*** For more information, turn to Reader Service Card, Circle No. 410**

NOW
for the first time...

PORCELAIN ENAMEL
is being applied successfully—
Yes, even spectacularly—
with RANSBURG NO. 2 ELECTROSTATIC SPRAY PROCESS



General Electric—an extensive user of Ransburg Electro-Spray for painting with synthetic enamels—is the first to use Ransburg No. 2 Process in the application of porcelain enamel.

GE—less than a year in electrostatic production—now is processing almost a million square feet of cover coat each month in the General Electric Home Laundry finishing department at Appliance Park.

DRYER TOPS AND WASHER COVERS ARE BEING COATED ELECTROSTATICALLY WITH THESE SPECTACULAR RESULTS

Quality of appearance and chip resistance are greatly improved with all colors: white, yellow, pink, turquoise, blue and brown.

About 97% of the atomized enamel is deposited on the washer and dryer parts.

Because of improved uniformity in coating thickness, weight of applied enamel was substantially reduced.

Because of lower application weight, the few rejected parts can be re-processed more times before being scrapped. This reduces the ultimate scrap rate by at least 95% of that previously expected.

Efficiency, measured by the amount of good ware, averages above 90%.

Want your products tested?

Ransburg has fully equipped laboratory facilities including reciprocating disks, helical conveyors, stationary disks, and the latest advancements in equipment for applying porcelain enamel with the No. 2 Electrostatic Spray Process. Manufacturers are invited to send sample products to our Indianapolis laboratories for tests and demonstrations to prove for you the advantages and benefits of electrostatic spray application of porcelain enamels.

Ransburg ELECTRO-COATING CORP.
Indianapolis 7, Indiana
RANSBURG

For more information, turn to Reader Service Card, Circle No. 368

OTHER NEW MATERIALS PRODUCTS

PROPERTIES OF EPOCAST PASTES

No.	Spec Grav	Ten Str, psi	Comp Str, psi
150	1.19	6000	17,000
151	1.58	6000	18,000
152	1.24	3500	8500
153	1.19	4900	9300
154	2.76	5300	16,700
155	1.58	6000	16,700
156	1.63	5200	18,000

col, JP-4 jet fuel, salt spray, Skydrol 500 and many other chemicals.

Epocast 150 is a natural colored paste material with the consistency of vegetable shortening. Used as a rigid sealant for polystyrene foam, it is a completely thixotropic paste that will not run on a vertical surface.

Epocast 151 is a flat aluminum colored material developed for aircraft honeycomb edge filling, metal splining and patching.

Epocast 152 is called a plastic solder. Developed originally to replace lead in automotive repair shops, it is used where a tough metallic finish is needed.

Epocast 153 is a cream colored paste that cures to a rubber consistency.

Epocast 154 contains 80% powdered iron and is used for patching plastic or metal tools and dies.

Epocast 155 is a mineral filled, thick gray paste suitable for high temperature service as an adhesive, space or gap filler or caulking material. An elevated temperature cure is recommended for optimum properties.

Epocast 156 is a wipe-on white paste for filling pores in polyester or epoxy laminates. It is also a wood or plaster sealer.

The seven pastes range from 0.00061 to 0.00160 in shrinkage (in. per in.), from 1500 to 2800 psi in lap shear strength and from $2.1x10^5$ to $5.8x10^5$ in coefficient of expansion at 40 to 70 F. They cure in 24 hr at room temperature and post cure in 1 hr at 200 F.

(more New Materials on p 158)

PERHAPS WE'LL HAVE TO ADD A PINCH, FOR YOU . . .

Just ask us for an alloy we haven't got — we'll be delighted.

Because that's how each of the more than112 resistance and electronic alloys Driver-Harris makes had its beginning. Each of these highly specialized alloys is custom-made . . . produced exactly to the specifications of our customers.

The physical and chemical properties of an electrical resistance alloy can be altered greatly by a minute difference in its constituents. Often just a few ounces to the ton can make the difference you need.

One thing you can always rely on in any Driver-Harris alloy: it is made to the most precise metallurgical checks and controls known to the industry. It is these exclusive quality controls that have made Nichrome V and Nichrome* the standard for over 50 years by which all other electrical resistance alloys are measured.

Perhaps in a sense Nichrome is *too* well known. For we don't want people to forget that we make many other resistance alloys of sustained high quality to meet other special needs. And that, as we said at the outset, our engineers will be more than delighted to start afresh tomorrow to devise a new one, custom-made for you. Just tell us as exactly as you can what you wish to accomplish.

NICHROME V and NICHROME
are manufactured only by

SPECIAL PURPOSE ALLOYS SINCE 1899
D/H
TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris
Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville,
Los Angeles, San Francisco

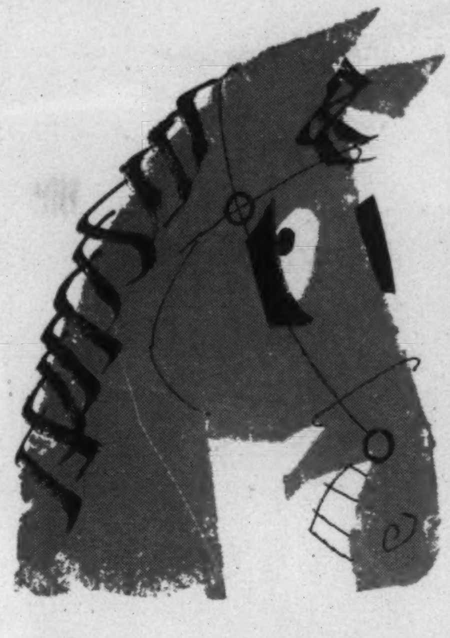
In Canada: The B. GREENING WIRE COMPANY, Ltd.,
Hamilton, Ontario.

*T. M. Reg. U. S. Pat. Off.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

For more information, turn to Reader Service Card, Circle No. 476

It's good Horse Sense to choose SPEER Carbon Brushes



You hold a pay-off ticket when you specify Speer application-tested brushes for any fractional horsepower installation. Every Speer brush is a performance-proved winner, tested in the laboratory and on the job to give you . . .

- **EVEN WEAR**
- **IMPROVED COMMUTATION**
- **REDUCED VIBRATION**
- **LONGER BRUSH LIFE**

Through 50 years of carbon and brush specialization, Speer has developed a broad variety of carbon and graphite brushes to meet the requirements of every type installation. *Write today for "Brushes by Speer"* containing valuable data on the characteristics and applications of Speer's complete line of brushes.

SPEER Carbon Co.
St. Marys, Pa.

Send catalog: "Brushes By Speer"
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Title________________
Address________________
City________ State________

For more information, Circle No. 375

OTHER NEW MATERIALS PRODUCTS

Nickel and Brass Coated Steel Wire

A nickel coated steel wire, known as Fernicklon, is now available in commercial quantities from *National - Standard Co.*, Niles, Mich. The material was developed several years ago by Kenmore Metals Corp. (see M&M, May '52, p 96) and rights to it were acquired by National Standard last year.

The wire is supplied in a range of sizes from 0.010 to 0.310 in., depending on tensile strength, in either matte or superbright finish. The matte finish has a residual surface lubricant useful in some forming operations and can be brought to a high luster by tumbling or burnishing. The wire has proved successful in grid supports and lamp leads.

Brass coated wire in sizes from 0.072 to 0.310 in. is also available. It is recommended only for decorative effects in furniture and accessories. Typical products include curtain rods, drapery hardware, indoor television antennas, fireplace equipment and grilles.

New Film Packages Acid, Machine Parts

A clear plastic film for packaging everything from acid to precision parts in tough sealable bags is available from *Minnesota Mining & Mfg. Co.*, Dept. L6-106, 900 Fauquier St., St. Paul, Minn.

The new film is claimed to be the first durable plastic packaging material that combines the strength and resistance to oil of polyester films with the resistance to corrosive fluids and heat sealable properties of polyethylene films.

The film is chemically inert and nontoxic, and has "excellent" resistance to boiling, moisture and gas permeation. It can package most lubricating and food oils and oil based products, cosmetics,

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington and Dover, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
DeLaval Steam Turbine Co., Trenton, N. J.
Empire Pattern & Foundry Co., Tulsa, Okla.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machine Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundry Co., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Kennedy Van Saun Mfg. & Eng. Corp., Danville, Pa.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Shenango-Penn Mold Co., Dover, Ohio
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

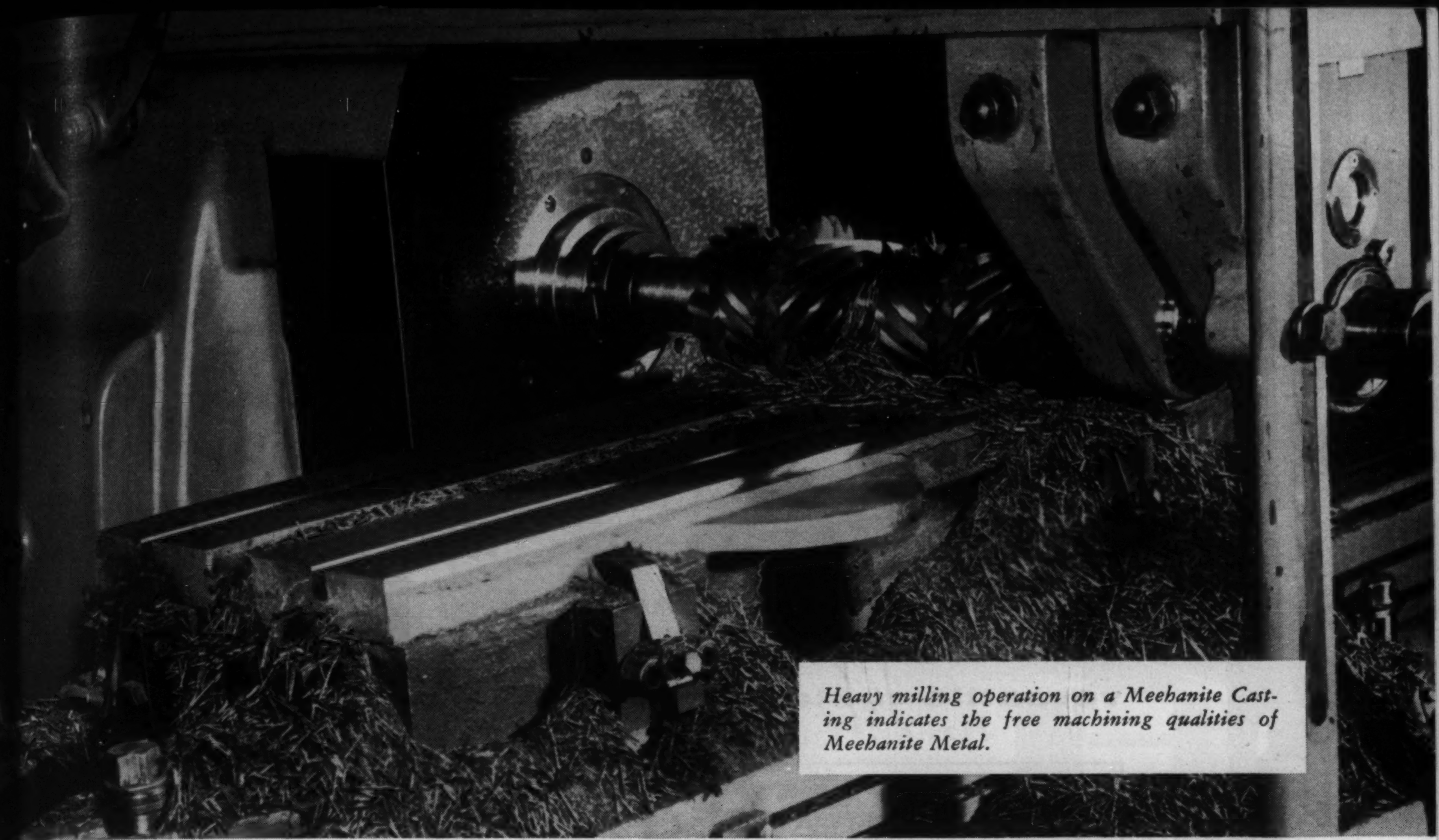
HOW TO MACHINE MEEHANITE CASTINGS

SEND FOR BULLETIN TODAY

● "HOW TO MACHINE MEEHANITE CASTINGS" BULLETIN NO. 29

MEEHANITE®

For more information, Circle No. 533



Heavy milling operation on a Meehanite Casting indicates the free machining qualities of Meehanite Metal.

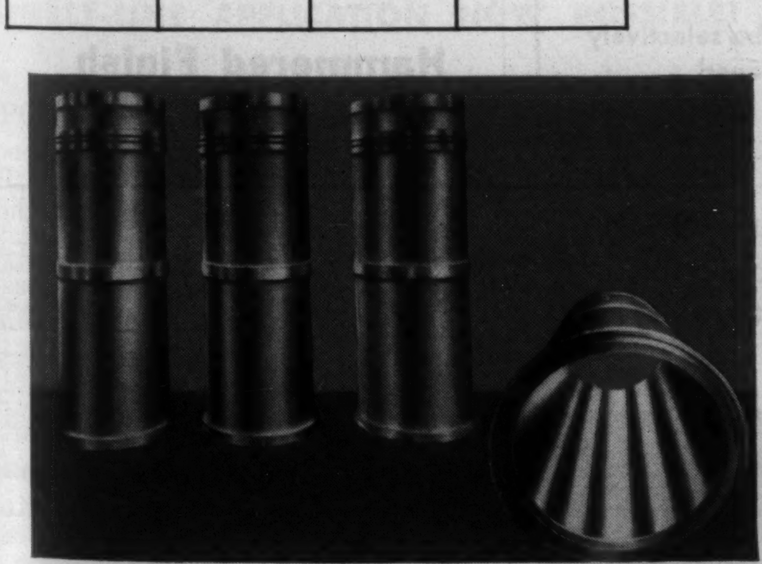
FREE MACHINABILITY OF MEEHANITE CASTINGS INCREASES TOOL LIFE, REDUCES MACHINING COSTS

Machining time to turn, bore, face, key seat, drill, tap and cut on a 3 ft. worm gear. The tabulation below shows savings possible with Meehanite Metal.

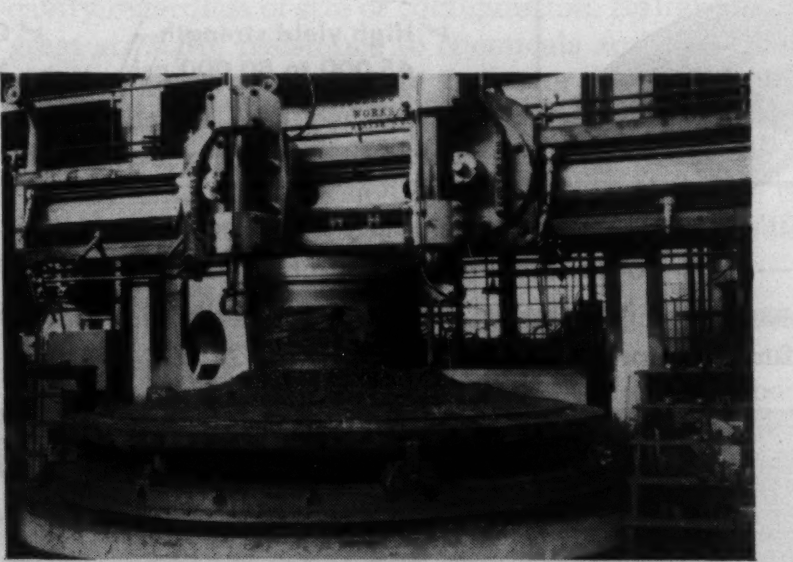
STEEL CASTING 69,000 psi	ALLOY CAST IRON 40,000 psi	MEEHANITE TYPE GB 45,000 psi	MEEHANITE TYPE GB 45,000 psi
183 lbs. metal removed in 20.1 hours.	170 lbs. metal removed in 15.83 hours without coolant.	170 lbs. metal removed in 10.53 hours without coolant.	170 lbs. metal removed in 7 hours with coolant.

The consistent and uniform machining characteristics of the engineering types of Meehanite Metal result from a unique manufacturing process which controls the microstructure of the casting. The homogeneity of structure and uniformity of casting soundness permit higher feeds and faster speeds, thereby reducing to a minimum machining costs as well as casting rejects. Retention of accuracy of casting form and size allows Meehanite castings to be made within definite dimensional limits to further reduce machining costs.

For additional information on the machining advantages of Meehanite, write today for Bulletin No. 29, "How To Machine Meehanite Castings."



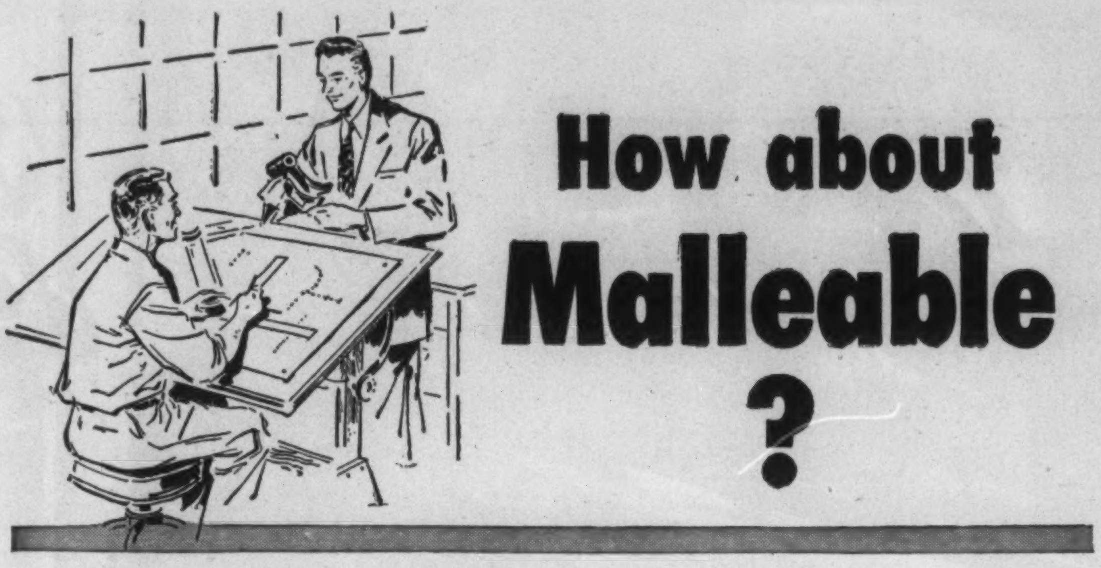
Cylinder liner weighing 1100 lbs. were cast in Meehanite type "GB" to give a high machine polish.



Meehanite Ball Mill Head 12 ft. O.D. with 44" diameter trunnion. 3/4" deep cut at 140 ft./min. cutting speed removed 37.8 cu. in./minute.

MEEHANITE METAL®

MEEHANITE METAL CORPORATION • NEW ROCHELLE • NEW YORK



How about
Malleable
?

...Don't overlook the advantages of this highly versatile material!

STANDARD malleable iron is a strong cast ferrous alloy having a remarkable combination of properties:

- ✓ Toughness and ductility
- ✓ High impact resistance
- ✓ Excellent machinability
- ✓ Resists corrosion

...and how about Pearlitic Malleable?

PEARLITIC malleable iron is a special type of malleable having these unique characteristics:

- ✓ Exceptional bearing properties
- ✓ High yield strength—45,000 to 80,000 psi.
- ✓ Easily machined
- ✓ Can be selectively hardened

It's easy to design for simplicity and good appearance in malleable iron—helps you cut costs on current production. Consult your nearest malleable foundry or write to the Malleable Founders' Society for further information.

Malleable
FOUNDERS' SOCIETY

1800 Union Commerce Building
Cleveland 14, Ohio

For more information, turn to Reader Service Card, Circle No. 463

***Heat sealable film** has tensile strength greater than 15 psi.*

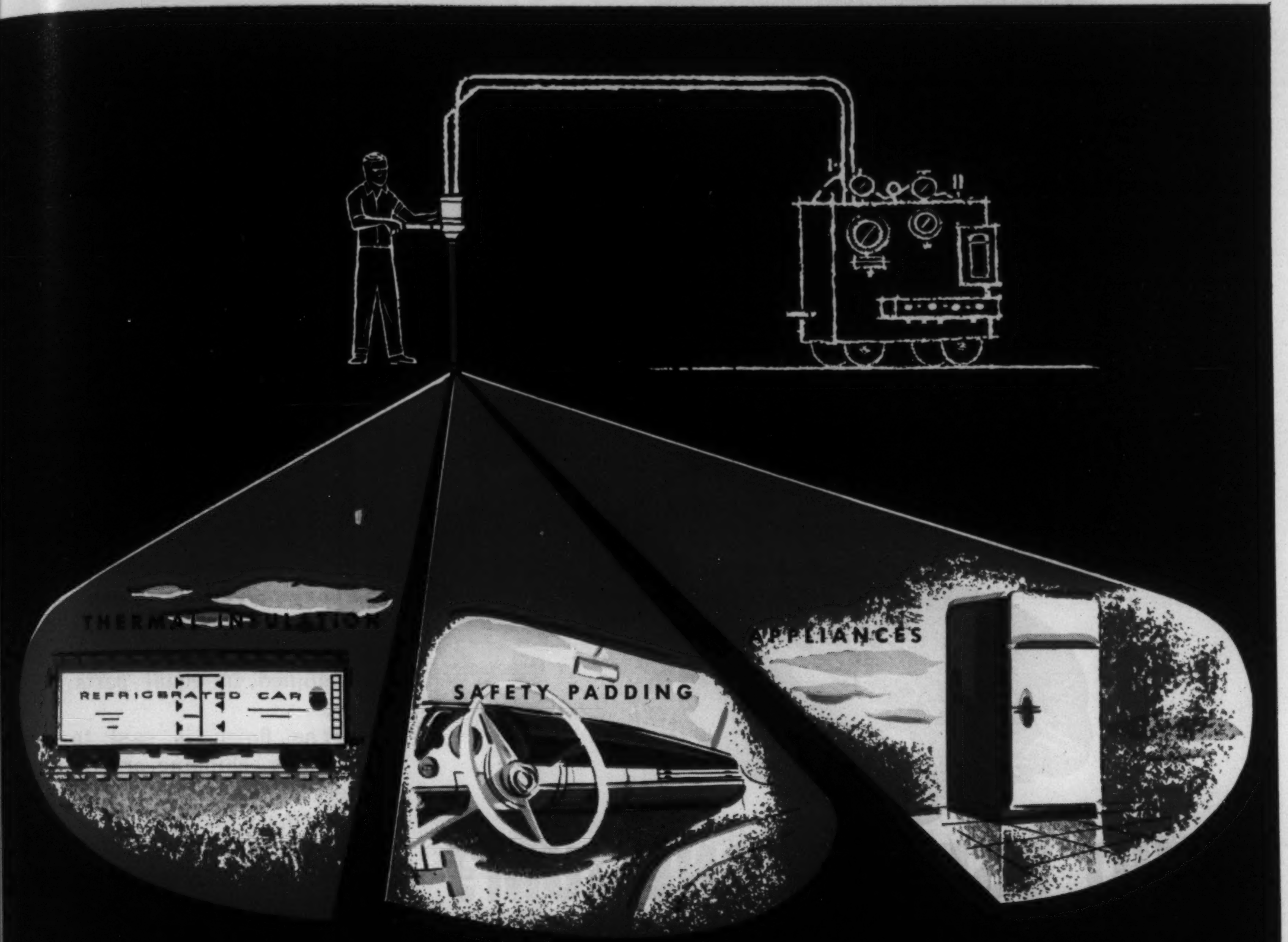
drugs, and corrosive chemical agents. According to 3M, the film has good puncture resistance and can be used for dry or wet packaging of machine parts with critical surfaces, such as bearings, engine parts and gear mechanisms.

The film can be heat sealed to provide a bond stronger than the film itself at temperatures of 275 to 350 F, jaw pressures of 10 to 60 psi and dwell times of ½ to 2 sec. Tensile strength is greater than 15 lb per in. of width. The film is priced several times higher than cellophane and most other transparent films.

Hammered Finish Applied by Spray

A new hammered finish is provided by a quick air drying, chemical hardening synthetic resin coating. It is claimed to possess good hiding qualities, durability and resistance to chemicals, solvents, moisture, weather and abrasion. Called Poly-Ep Platon, it has been developed by *Minnesota Platon Corp.*, Pipestone, Minn.

The composition, formulated basically from polyamide and epoxy resins in suitable solvents, is supplied as a two-component system. The two solutions are



presenting

THE NOPCOMETER

New automatic metering, mixing and dispensing unit for all NOPCO LOCKFOAM plastics

ASSEMBLY-LINE APPLICATION NOW POSSIBLE!

Now, many months of development have produced the NOPCOMETER—which makes mass production with Nopco Lockfoams a reality. Now you can meter, mix and dispense any of the Lockfoam formulations and deliver to your production line a predetermined charge of Lockfoam, *automatically*...and *intermittently*.

The Nopcometer makes possible assembly line manufacture of both small and large units. It can deliver Lockfoam of any required density at varying rates up to 15 pounds per minute.

Nopco Lockfoam can be *foamed-in-place* to fill any cavity regardless of size or configuration. Its light weight, great strength, resistance to chemicals and superior insulating qualities meet more than ever the specifications of *both* design engineering *and* production. In less than 25 minutes a section of 320 sq. ft. x 6" thick can be foamed. Similar time saving performance is made possible in auto crash pads, refrigerator panels and other products.

Nopco's technical staff is prepared to give assistance in operating the Nopcometer as well as to continue helping you develop Lockfoam formulations designed specifically to produce the best results for you at maximum economy. We welcome your inquiry.

NOPCO

PLASTICS DIVISION

HARRISON, NEW JERSEY • Los Angeles, Calif.

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WHO USES MAGNESIUM?
...and why

Look for the product that's out front in its field . . . and you know *who* uses magnesium! Why? . . . because design engineers and manufacturers alert to today's market conditions are quick to realize the added sales advantages of the product *made of magnesium.* Lightest of the world's structural metals, magnesium can be cast, formed, extruded, drawn or worked into virtually any size or shape! A *modern* metal in every sense, its lightness, strength and weight-saving characteristics are without equal. Even more important are the cost-savings to be gained in many areas of manufacture. The use of magnesium frequently results in *lowered* tooling costs—savings in machining, fabrication and processing costs—and reduced handling and assembly costs!

Magline Inc. has assisted many leading companies in developing better products through the application of magnesium. Magline engineers are qualified by years of experience in this specialized field, and can assist you with design and technical problems. Magline facilities are extensive and complete—from foundry . . . to fabrication . . . through final assembly! For quality production—short or long runs—you can depend on Magline for prompt service and delivery.

Send us part prints of your current requirements for quotation, or write today for your copy of Bulletin No. 50. Your request will receive immediate attention.

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fabrication facilities for

- Forming
- Machining
- Welding
- Stamping
- Spinning
- Deep Drawing
- Polishing
- Finishing
- Stress Relieving
- Assembly
- Impact Extruding

foundry facilities for

- Sand Castings
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Design and Engineering Services Available

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CANADIAN FACTORY: MAGLINE OF CANADA LTD., RENFREW, ONTARIO.

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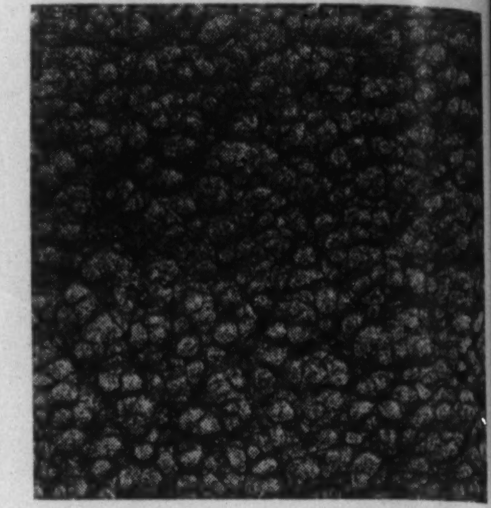

Epoxy-polyamide finish, *applied by spray, gives hammered pattern.*

combined in equal parts before use.

The finish is said to resist cracking, chipping or peeling under impact. It is unaffected by common household chemicals, grease, acids and alkalies, and has good dielectric properties. The finish may be applied to any metal surface by spray. It air dries dust free in 30 min. It may be handled in 6 or 8 hr or it may be completely cured at temperatures up to 350 F in 6 min. Two coats usually give a full gloss. It is available in various colors, in gloss or satin.

Reinforced Polyester Molding Compound

A medium impact nylon rag-reinforced polyester (alkyd) molding compound is claimed to have many advantages over currently available rag filled phenolic compounds. Designated Thermaflow 1000, it was developed by *Thermaflow Chemical Corp.*, Tunkhannock, Pa.

The compound has a bulk factor of 1.5. It will flow under pressures of less than 1000 psi and may be transfer or compression molded even in large housings with deep draws. Available in an extruded form, it requires no preforming. Minimum shelf life is 3 mo.

Moldings have a smooth, glossy

TWO
GREAT
NAMES

Teamed For Quality...Service...Progress

Two steelmakers, each known for its achievements in its own particular field of producing forged and annular rolled products are now combined to supply requirements of the largest and smallest. Two groups of production and research engineers are joined to better serve American industry. The new company is a totally owned subsidiary of Heppenstall and will operate independently. Each company will continue to offer American industry the custom made products for which it is famous.

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MIDVALE - HEPPENSTALL CO.

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A SUBSIDIARY OF HEPPENSTALL COMPANY

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AIRCRAFT
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Whatever your product requirements..

YOU'LL DO BETTER
WITH UNITCASTINGS!

We make no *special* claims to produce miracles with cast steel. Like competitive foundries, problems are similar . . equipment may differ slightly . . it's the *end performance* of the casting that counts!

A little *extra* surveillance in process pays off quality-wise. Customers receive better, cleaner castings . . meeting accepted specifications . . and end up with a lower *finishing* cost. Less scrap . . less re-work . . and less lost production time amounts to more than incidentals!

Standard carbon and low alloy steel castings, up to 150,000 psi tensile . . whatever your requirements, specify Unitcastings!

UNITCAST CORPORATION • Toledo 9, Ohio
In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast
QUALITY STEEL CASTINGS

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OTHER NEW MATERIALS PRODUCTS

PROPERTIES OF MOLDINGS

Izod impact, ft-lb/in. notch	3.2
Flexural strength, psi	6000
Compressive strength, psi	13,000
Modulus of elasticity, psi	0.73×10^6
Heat distortion temp. (264 psi), F	250
Tensile strength, psi	3500
Water absorption, %:	
24 hr at 73 F	0.11
7 da at 73 F	0.34
Specific gravity	1.5
Mold shrinkage (approx.) in./in.	0.010
Arc resistance, sec	125
Dielectric strength, v/mil	250
Dielectric constant:	
60 cycles	4.6
1 megacycle	4.2
Dissipation factor:	
60 cycles	0.02
1 megacycle	0.04
Volume resistivity, ohm-cm	$>1 \times 10^{14}$

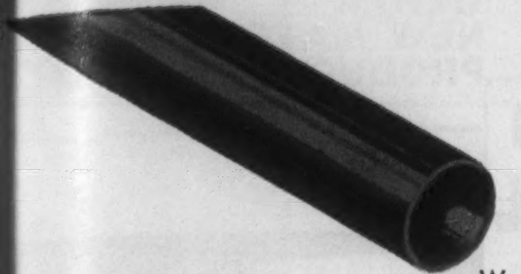
surface with none of the rippling associated with high impact materials. The material resists alkalies, bleaches and detergents up to 180 F and has good resistance to acids and organic solvents. Other properties are given in the accompanying table.

The compound is now used for a battery case attached to a portable amplifier. Available in any color, it is being considered for adding machine cases, phonograph housings and other cases of this type where strength and an attractive surface are necessary.

Flattened Strand Rope Has Higher Strength

A high strength grade of flattened strand wire rope is available from *Leschen Wire Rope Div., H. K. Porter Co., Inc.*, 2727 Hamilton Ave., St. Louis 12, Mo. Called Porter Imperial Red-Strand Wire Rope, it is 15% stronger than rope previously offered. The division is now making all rope of this quality with steel cores.

(more New Materials on p 166)

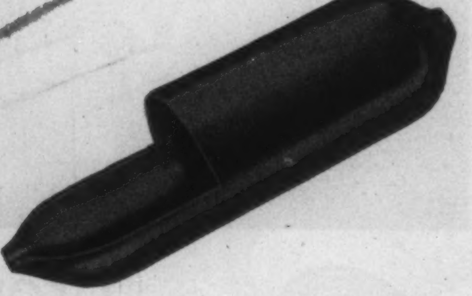


Wolverine com- ercial straight length tubing is available in a wide range of izes and tempers in both copper and aluminum.

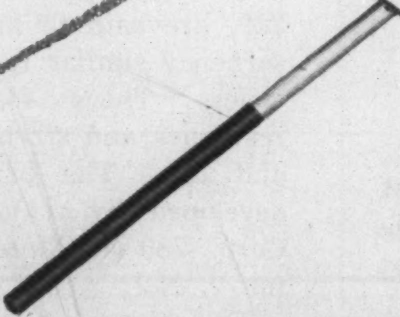
Wolverine Trufin*—the integral finned tube—boosts heat transfer performance. Available in copper, aluminum, steel and in a bimetallic form.

YOUR BUY WORD *in Copper* ...WOLVERINE

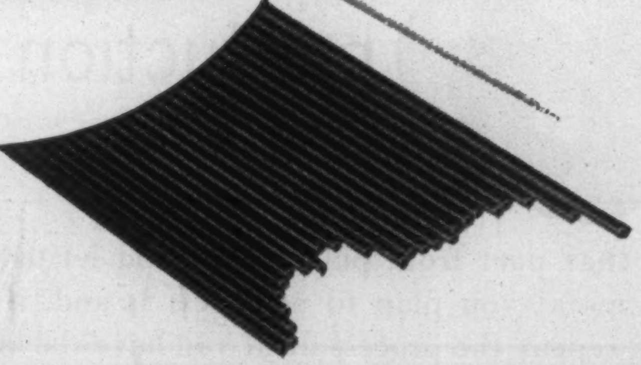
Wolverine is equipped to make simple or complex bends to customer specifications. Other fabrication services include such operations as beading, swaging, flaring, expanding, reducing, etc.



Wolverine's Copper Spun End Process** produces one-piece tubular-shaped parts in one fast, economical operation.



Wolverine copper-to-aluminum connectors permit the use of both metals in the same refrigeration ystem—are available in ⅜″ and 5/16″ tube diameters.



Wolverine Capilator*, copper capillary tube, assures precision metering of liquids, gases and air.

Here are six copper tube ideas—each designed to do a vital job in your product—each designed to save you time and money. All of them result from Wolverine's years of metalworking experience, constant research, and the imagination of skilled engineers. All products typify creative Tubemanship in action.

When your specifications call for copper and copper-base alloy tubing and tubular-shaped parts, remember Wolverine as your "buy" word. Remember, too, that Wolverine also manufactures a complete line of aluminum tube products as well. Wolverine's General Products Catalog has the complete story. Write for your copy today.

Wolverine Tube, 1439 Central Ave., Detroit 9, Mich.

*REG. U.S. PATENT OFFICE

**A PATENTED PROCESS RE. 22465

There is a difference in tubing and Tubemanship is that difference!

DIVISIONS OF CALUMET & HECLA, INC.

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Division of Calumet & Hecla, Inc.

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Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

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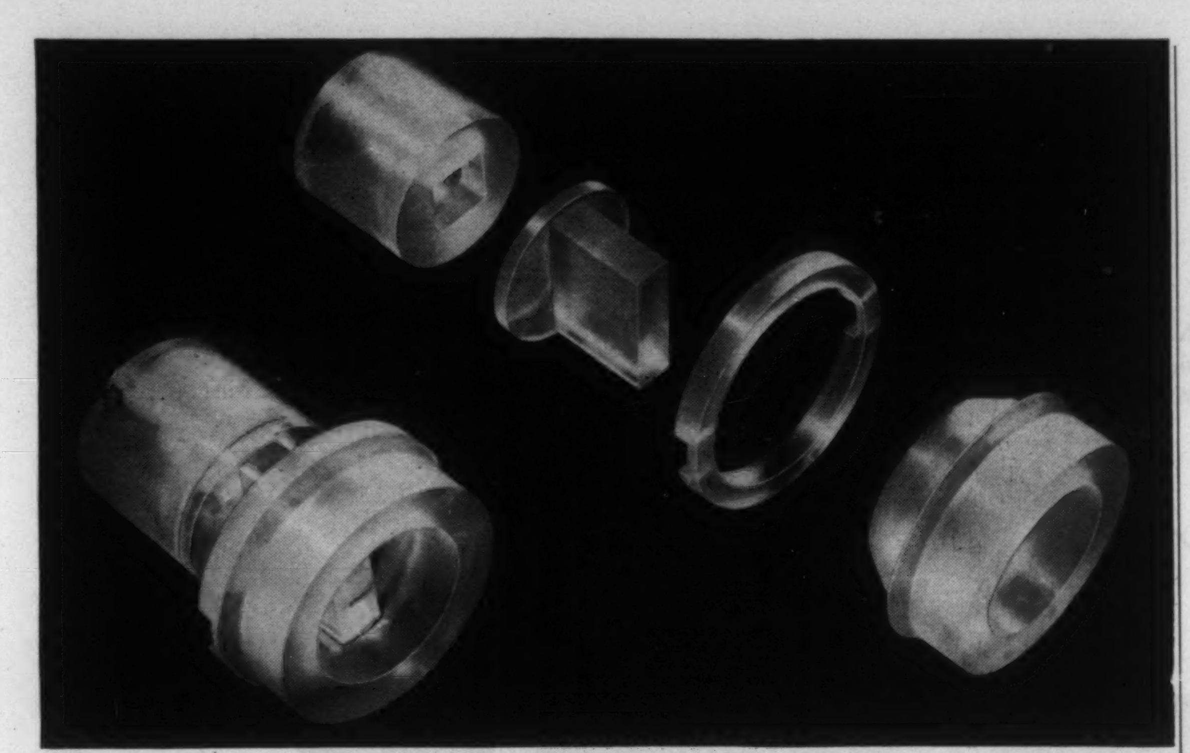
For more information, turn to Reader Service Card, Circle No. 489



prove it works **before** you go into production

Machine that part from polystyrene and let us investment-cast it in the metal you plan to use. Test it and, if some change is indicated, repeat the process until you have the final answer. This cut-and-try method of proving a design and an alloy saves you a lot of time and money.

Polystyrene machines readily and is inexpensive. Complex patterns can be made in sections and assembled, then cast as a unit just as they'd be investment-cast in quantity. Thus parts for testing are exactly like you'll get in production, but they cost far less than cutting them out of metal.

Technical Data Available

When your idea is on paper, but before you start to make the polystyrene patterns, send us a blueprint. We'll figure the shrinkage factor for you, suggest possible gating arrangements and design modifications which may effect further economies.

The pamphlet, *A Guide for Making Polystyrene Patterns*, describes methods of machining and names sources from which this material can be obtained. For a free copy, write Precision Metalsmiths, Inc., 1077 East 200th Street, Cleveland 17, Ohio.

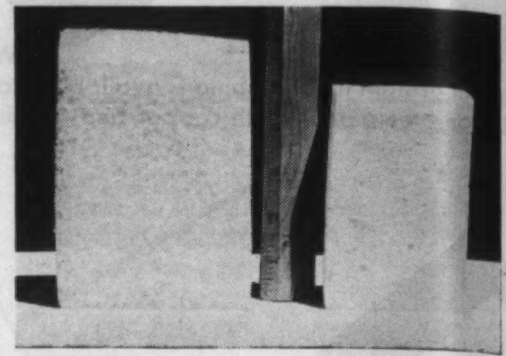
pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

For more information, turn to Reader Service Card, Circle No. 396

OTHER NEW MATERIALS PRODUCTS



New foam, *left, absorbs more water than conventional urethane foam.*

Urethane Foam Has High Water Absorption

Conventional urethane foams are hydrophobic but foams prepared from a new urethane prepolymer, designated Thiokol ZL-239, are said to have water absorbency similar to that of cellulosics. These foams combine resilience and strength, both wet and dry. The prepolymer was developed by *Thiokol Chemical Corp.*, 780 N. Clinton Ave., Trenton 7, N.J.

Typical water absorbency values for the foams are near 1200% by weight. These properties indicate their use for household and industrial sponges.

At a density of 4.5 lb per cu ft, the foams have a tensile strength of 22 psi dry and 11 psi wet. Dry elongation is 300%, wet 175%. Variations in density can be obtained by adding more water to the catalyst mix. Foams can be made in a variety of colors.

The prepolymer is available as a three package mix and can be processed into foam with simple equipment. One component is an emulsifier. The second is the prepolymer, consisting of a partially reacted diisocyanate and what is said to be a new polymer. (No further information on this polymer is available as yet.) The third component is a catalyst. The fact that the diisocyanate is partially reacted reduces the toxicity of the material, though normal precautions should be observed.

(more New Materials on p 168)

For more information, Circle No. 452 ➤

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DATA FOR DESIGNERS

NEW!

AlSiMag Alumina Ceramics open new fields for designers . . . permit designing to higher temperatures, higher frequencies, greater strengths.

Designers are generally familiar with the plus values of AlSiMag technical ceramics for standard industry applications. However, recent developments—particularly in new, high-strength, high-temperature AlSiMag Aluminas—have greatly enlarged their range of usefulness.

Do you need a material with such versatile characteristics as shown on this page? AlSimag technical ceramics have helped many designers solve problems . . . may help solve yours. Send blueprint with complete operating details for our recommendations.

PLANTWIDE VACATION—First Two Weeks of July

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CORPORATION
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A subsidiary of
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Manufacturing Company

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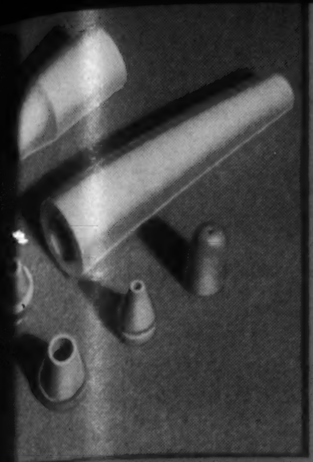

brasion Resistant
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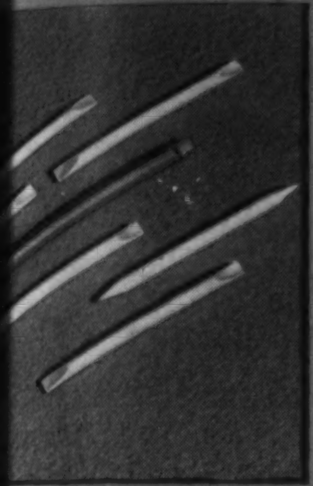
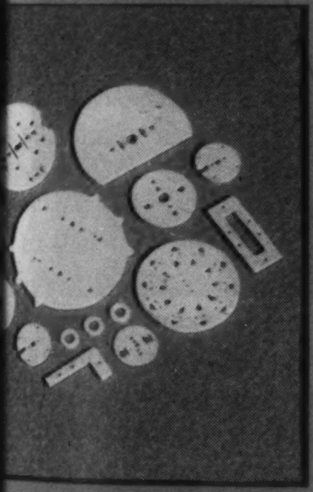
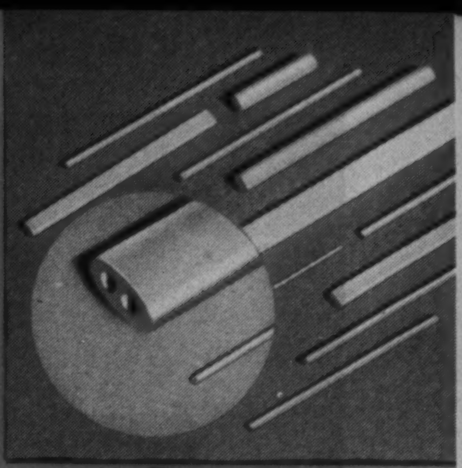


Non-Inductive
t Tool Blades. Non-metallic,
tive machine and instrument
other demanding applications.

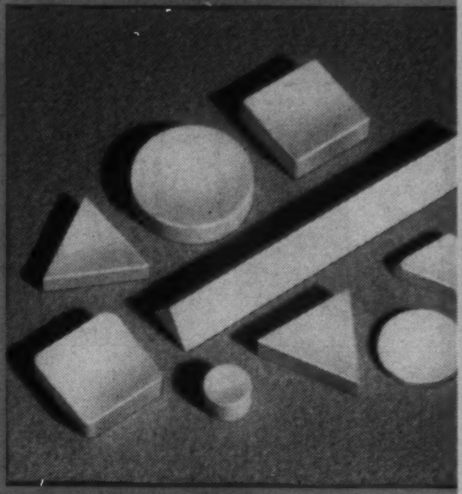


Thin . . . Strong
Tube Spacers as thin as .009"
arkable strength. Similar parts
ve other application problems
uperior insulation is needed.

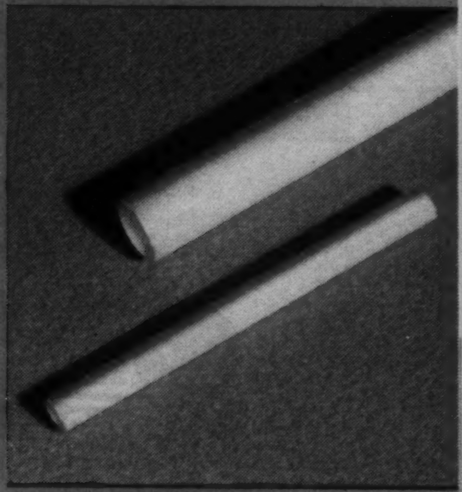
Precision Finishes
easily coated AlSiMag Cores
Metal Film and Carbon De-
Resistors.



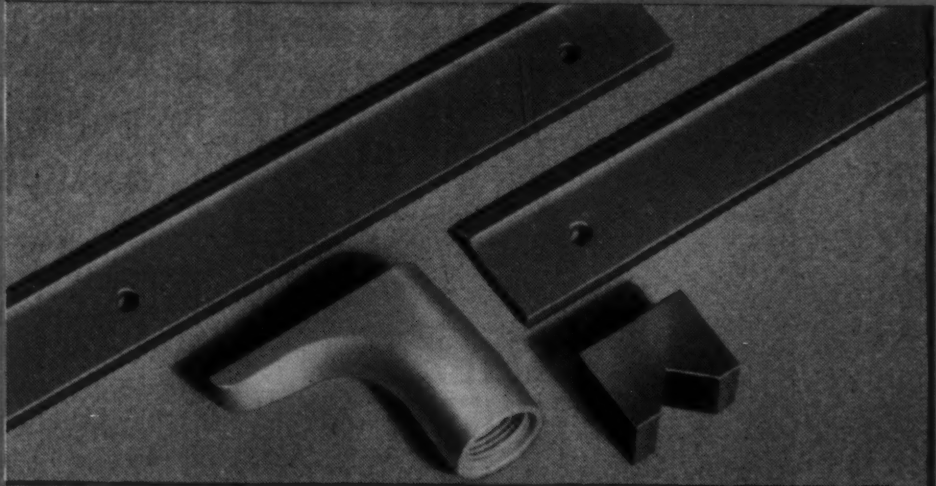
Precision Tolerances
Minute, yet strong tubing of AlSiMag Alumina. Parts in inset magnified three times (smaller one .013" OD); others approximate actual size.



Hard
AlSiMag Tool Tips for cutting and machining strongest alloy steels.



Durable
Rollers for flattening inductance wire—a new application for AlSiMag.



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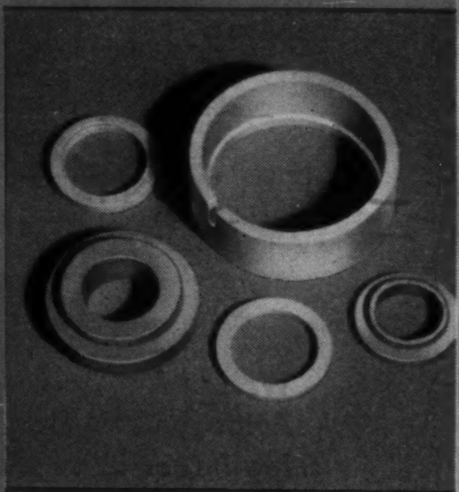

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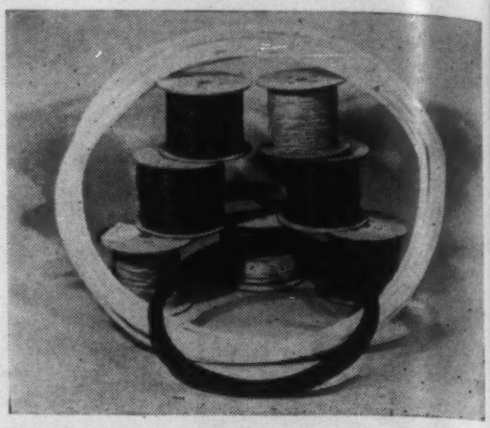
OTHER NEW MATERIALS PRODUCTS



Teflon *spaghetti tubing has continuous service limit of 480 F.*

Spaghetti Tubing Made from Teflon

A wide range of sizes of spaghetti tubing made from Teflon is offered by *Pennsylvania Fluorocarbon Co.*, 1115 N. 38th St., Philadelphia 4. Used for electronic and electrical applications, the tubing can be made in various colors for identification. It has a dielectric strength from 500 to 1000 v per mil, a dielectric constant of 2.0 and a dissipation factor of 0.0002. There is no change of electrical properties with temperatures from −210 to 480 F and frequencies from 60 cycles to 100 megacycles.

Spaghetti made from Teflon is used for instrument tubing, sheathing for several wires and, with bare wire, as a replacement for hook-up wire insulated with Teflon. Teflon tubing is advantageous in the assembly of aircraft, communication and electronic equipment because it is not harmed by the hot barrel of the soldering iron.

Multicolor Enamel for Speckle Finish

A new multicolor spray enamel that permits the application of two or more colors simultaneously has been developed by *The Glidden Co.*, 1396 Union Commerce Bldg., Cleveland, Ohio. Called Zatex, the new enamel is applied with standard spray equipment.

The Brauer Structural Panel of

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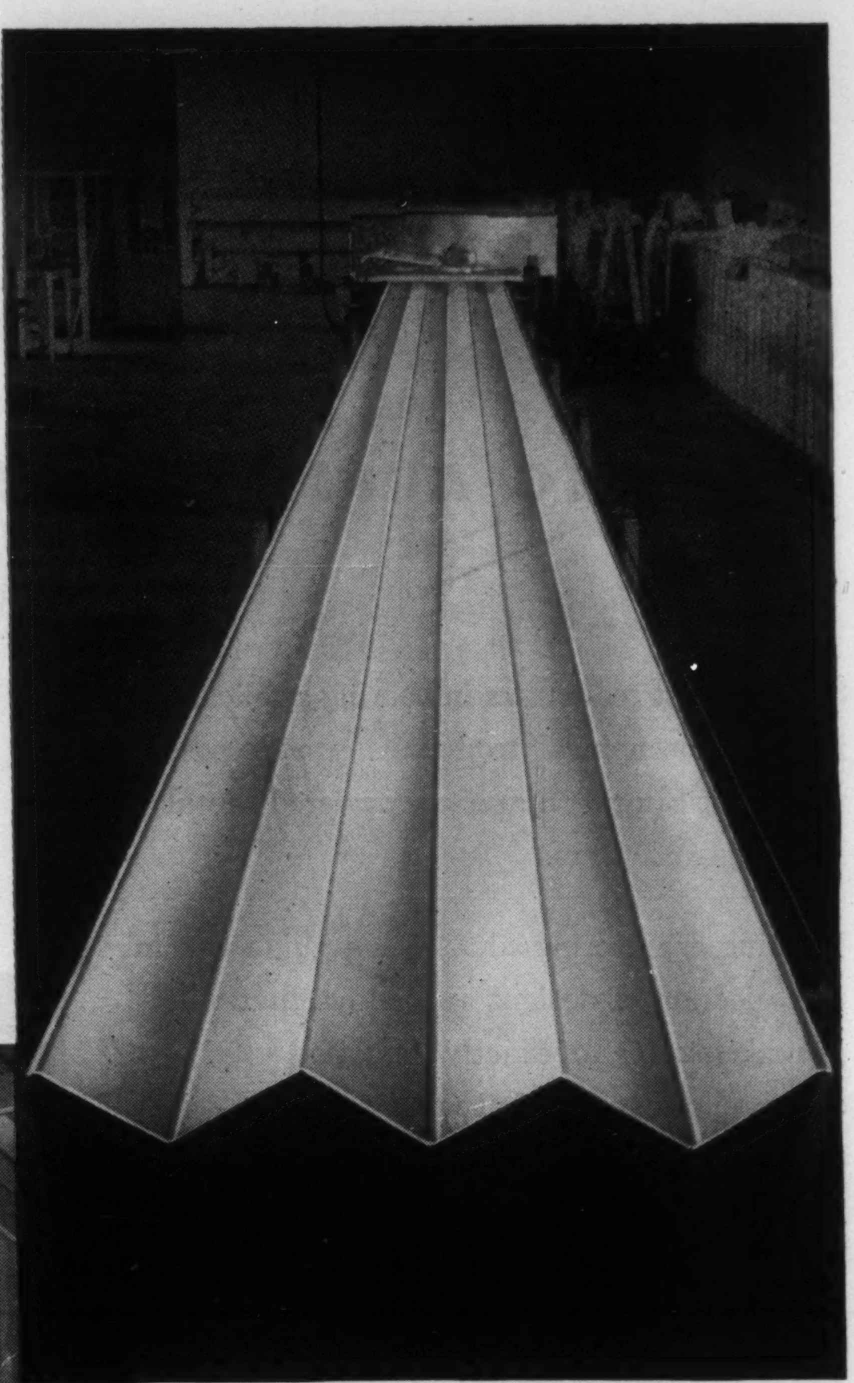

Roll forming machine, developed by Brauer Engineering Company, produces up to 3,500 feet of panel material per hour.

Structural aluminum panels developed by the Brauer Engineering Company, Corpus Christi, Texas, have been used in everything from garages to a church. And in every application the characteristics of strong, lightweight and rust-free aluminum have offered special advantages.

Rolled from 48″ wide, .040″ thick, 3003-H14 aluminum sheet, they are 40 inches wide and four inches deep when formed, and can be made to any desired length. Weight is only 0.69 pounds per square foot, yet a ten foot section will carry about 88 pounds per square foot uniform load at yield point. In application this eliminates at least half of the structural members.

Brauer also manufactures complete construction accessories for these panels adaptable to any type of building. A special groove at the top edge of the panels prevents side lap leakage, permitting construction of minimum pitch and even flat roofs without use of additional roof covering material. Since aluminum reflects 90% to 95% of radiant heat, these building panels provide their own insulation even though inside finishing materials are not used.

If your problems, like Brauer's, involve forming, you should own Reynolds highly informative 148-page handbook, "Aluminum Forming". Single copies free when requested on business letterhead. Ask also for complete literature index. Or you may want to work with the men of Reynolds Styling and Engineering Services. Write *Reynolds Metals Company, P.O. Box 1800-HM, Louisville 1, Ky.*

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time to re-examine

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and spray techniques. It is available in a wide range of color combinations and, according to the manufacturer, the decorative finish offers excellent coverage over surface irregularities and extreme washability.

The coating adheres well to metal, wood, plywood, ceramics, stucco, plaster, wallboard, brick and building block. Since the colors remain separated during the spray process a speckled finish is produced.

One gallon of Zatex has an estimated coverage of 100 to 125 sq ft. It can be sprayed at a wide range of fluid and air pressures; the greater the difference in pressures, the smaller the color particles and the spray pattern.

Zatex dries to the touch in 30 min and is ready to handle in 4 hr. In a baking operation, it will cure in approximately 2 hr at 140 F or 20 min at 225 F. Eventual surface wear and minor scratches are difficult to detect because of the surface texture and the continuity of the color pattern through the film thickness.

High Zinc Coating for Cold Galvanizing

A cold galvanizing compound has been developed to prevent rust, protect iron and steel surfaces and repair damaged galvanized surfaces. Called Drygalv, it is available from *American Solder & Flux Co.*, 19th and Willard St., Philadelphia. It is applied with a brush or spray gun and produces a coating with a high proportion of metallic zinc—about 95% in the dried film. The compound is nontoxic and dries in 15 to 30 min. Surfaces may be given a second coat or painted in 8 hr. The coating will withstand temperatures to 392 F for a limited time.

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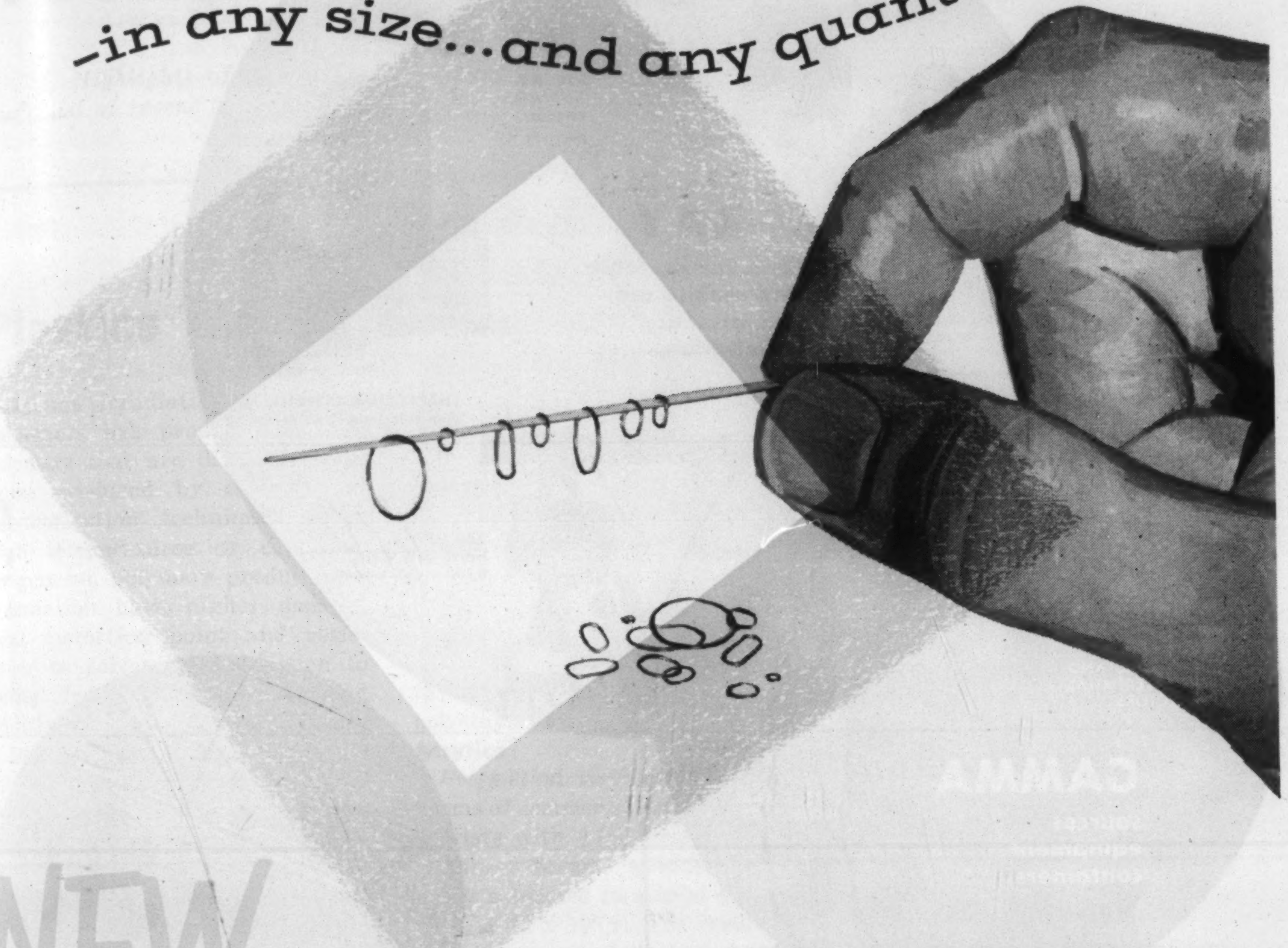

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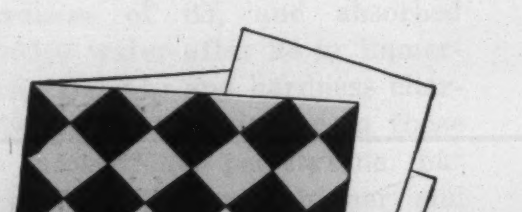
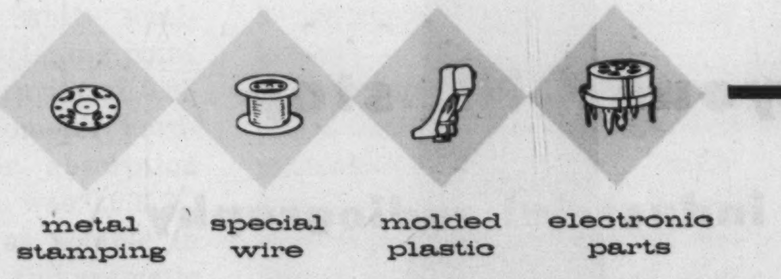


PARTS DIVISION



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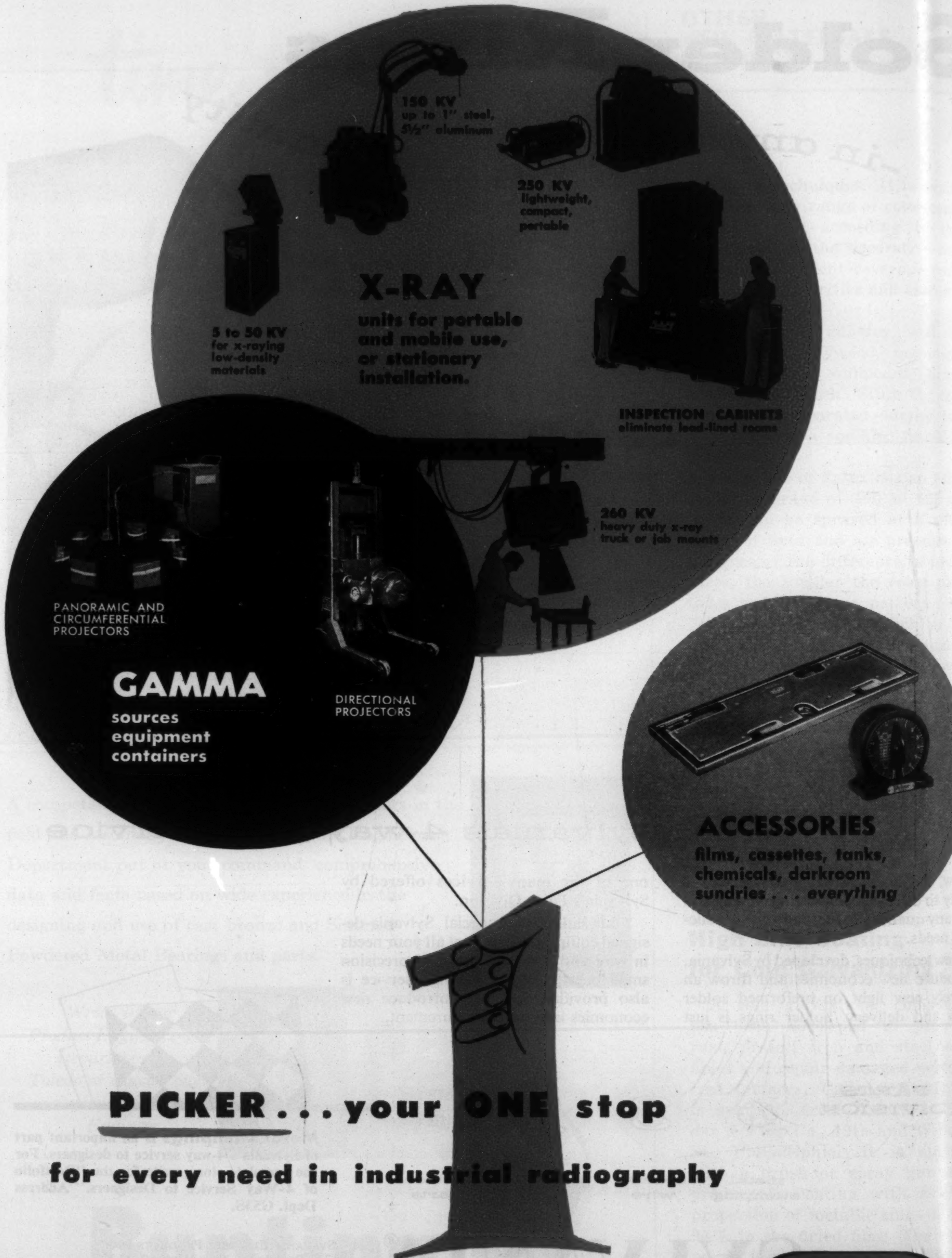
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CONTENTS NOTED

Highlights of current papers, plus a list of recent books and reports.

This month

- *Polymers synthesized by gamma rays*
- *60th Casting Congress papers*
- *Vinyl-silicone rubbers*
- *Aluminum-zinc casting alloy*

Plastics Tailor-Made by Gamma Irradiation

■ Gamma irradiation of certain monomers has produced plastics polymers that are different from those produced by conventional polymerization techniques using high temperatures or catalysts. In general, polymers produced by irradiation have higher density, heat distortion point and resistance to solvents, in addition to being free of adulterants and additives.

Polymers producible by this method include polyethylene, polystyrene, polymethylstyrene, acrylonitrile and polymethyl methacrylate. Also, some low molecular weight polyester syrups have been solidified into hard transparent solids by the method, and silicone rubbers have been vulcanized. Results of recent work are reported by T. D. Callinan of the Naval Research Laboratory in the May *Journal of the Electrochemical Society.*

Polyethylene

At an initial pressure of 1200 psi, 112 gm of ethylene gas were subjected to gamma radiation of 5 x 10^5 r per hr for 72 hr. The resulting 14 gm of white semi-fibrous solid had a softening point of 265 F, a specific gravity of 0.88 and a Shore A durometer hardness of 45. Water absorption after 24 hr immersion was 0.005%, and the material was soluble in chlorinated aliphatic and aromatic compounds at elevated temperatures.

The material had a sharp softening point that qualitatively proves the uniformity of molecular weight and freedom from crosslinking. It was readily moldable in standard plastics forming equipment at a temperature of 255 F and a pressure of 5000 psi. Under these conditions the material discolored to a deep brown. Pressing at lower temperatures and higher pressures yielded white soap-like products similar in appearance to conventional polyethylene.

Acrylics

Polymethyl methacrylate—Five grams of commercial methyl methacrylate with 0.1% benzophenone stabilizer became solidified after being subjected to a total gamma dose of 10 x 10^6 r. The resultant polymer was a clear transparent solid that could be molded at 370 F and 6000 psi pressure, but suffered distortion under mechanical stress at 295-305 F. This distortion is apparently a phase transition similar to that suffered by electron crosslinked polyethylene at 248 F. The material had a specific gravity of 1.20, a Shore D durometer hardness of 90, and 0.21% water absorption after 24 hr immersion. It was affected by ketones.

The major difference in properties between this polymer and conventional polymethyl methacrylate was a 60-70 F higher heat distortion point. This improved heat resistance may offer a solution to the problem of aircraft canopies distorting at skin temperatures caused by high air speeds.

Polymethyl acrylate — Five grams of commercial methyl acrylate was solidified by subjecting it to 40 x 10^6 r. The product was a clear, transparent, colorless elastomer which became brittle at 50 to 68 F but maintained form stability at temperatures up to 380 F. The material had a specific gravity of 1.19, a Shore D durometer hardness of 5, and water absorption of 0.4% after 24 hr immersion. It was soluble in ketones and chlorinated compounds. The material was 25% denser than conventional polymethyl acrylate. Its mechanical stability at elevated temperatures indicated a high degree of crosslinking.

Polystyrenes

Polystyrene—Ten grams of commercial styrene were irradiated with a total dose of 31 x 10^6 r. The resultant orange-brown clear, transparent solid had a specific gravity of 1.04, distorted at about 215 F, had a Shore D durometer hardness of 85, and absorbed 0.005% water after 24 hr immersion. Density and hardness characteristics were similar to those of conventional polystyrene, but heat distortion was higher and water absorption less. After standing at room temperature for 2 mo, or after being heated to 194 F, the sample bleached appreciably.

Polymethylstyrene — A sample consisting of 146 gm of commercial methylstyrene was subjected to 38 x 10^3 r. The resulting solid was orange colored, had specific gravity of 1.30, heat distortion temperature of 370 F, Shore D

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CONTENTS NOTED

durometer hardness of 91, and water absorption of 0.14% after 24 hr immersion. It was 20% denser than conventional polymethylstyrene and its heat distortion point was approximately 100 F higher. After heating, the polymer bleached to a color approaching that of conventional, colorless polymethylstyrene.

Other materials

Polyvinyl pyrrolidone—A sample consisting of 150 gm of commercial 1-vinyl-2-pyrrolidone was subjected to 2.2 x 10^6 r of gamma radiation and transformed into a hard, water-dispersible red solid. The solid swelled in water and had a specific gravity of 1.51 and a Shore D durometer hardness of 75. Density was 20% greater than that of conventional polyvinyl pyrrolidone.

Copolymers—The author briefly describes the results of producing copolymers of various monomers by radiation. Of the myriad of combinations possible, 50:50 pairs of acrylonitrile, methyl methacrylate, styrene and methyl acrylate were prepared and subjected to irradiation. A variety of properties and characteristics were obtained.

Polyesters—Commercial polyester liquids (Paraplex P-43, Laminac 4116 and Laminac 4128) were subjected to irradiation and readily converted to solids. These solids differed from conventionally prepared polyester solids in the following ways: they were 10-12% denser, they were usually yellow-pink, they shrank more on curing and they frequently absorbed less water after 24 hr immersion. Continued irradiation of the polymer after initial solidification increased hardness, raised heat distortion point and intensified color. Continued irradiation of Paraplex P-43 up to 270 x 10^5 r, for example, resulted in a final heat distortion temperature of 310 F.

Silicones—Silicone oils on being subjected to gamma radiation are converted into products resembling rubber. Thus, the crosslinking and polymerization of polysiloxanes by gamma rays is sometimes referred to as vulcanization. Irradiation of 10 gm of silicone oil having an initial molecular weight of 400,000 produced a clear transparent elastomer having a tensile strength of 110 psi, a density of 0.932 and a water absorption of 0.2% after 24 hr immersion. By blending 40% silica in the initial oil, a tensile strength of 1100 psi was obtained.

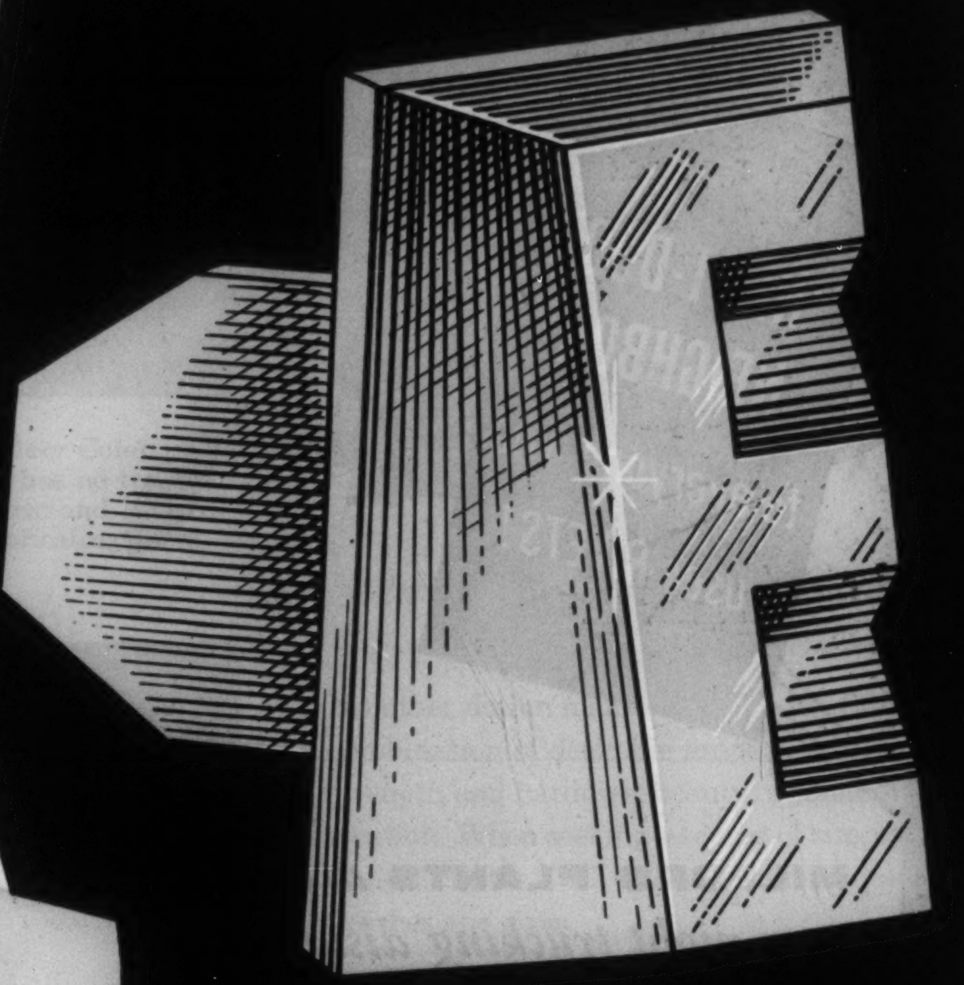
Foundrymen Discuss New Alloys

Although papers delivered at the 60th Casting Congress of the American Foundrymen's Society held recently were concerned largely with foundry practice, a number of them dealt with new alloys. Materials discussed included gray iron, malleable iron, copper, bronze, magnesium alloys and aluminum alloys. Abstracts of a number of these papers follow.

Malleable spheroidal iron

Malleable base spheroidal iron is a new high strength alloy having graphite in a spheroidal form in a stable matrix. This material was discussed by F. B. Rote, E. F. Chojnowski and J. T. Bryce of Albion Malleable Iron Co.

The authors pointed out that the new material is produced from the conventional duplex metal used in most pearlitic and ferritic malleable practice. Addition of sufficient sulfur and a solid-state graphitizer causes the formation of spheroidal graphite during annealing. The new material is structurally stable and can be heat treated to high strength levels. For example, samples



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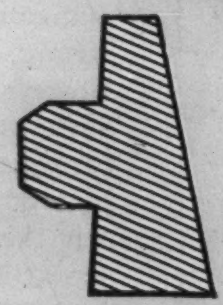

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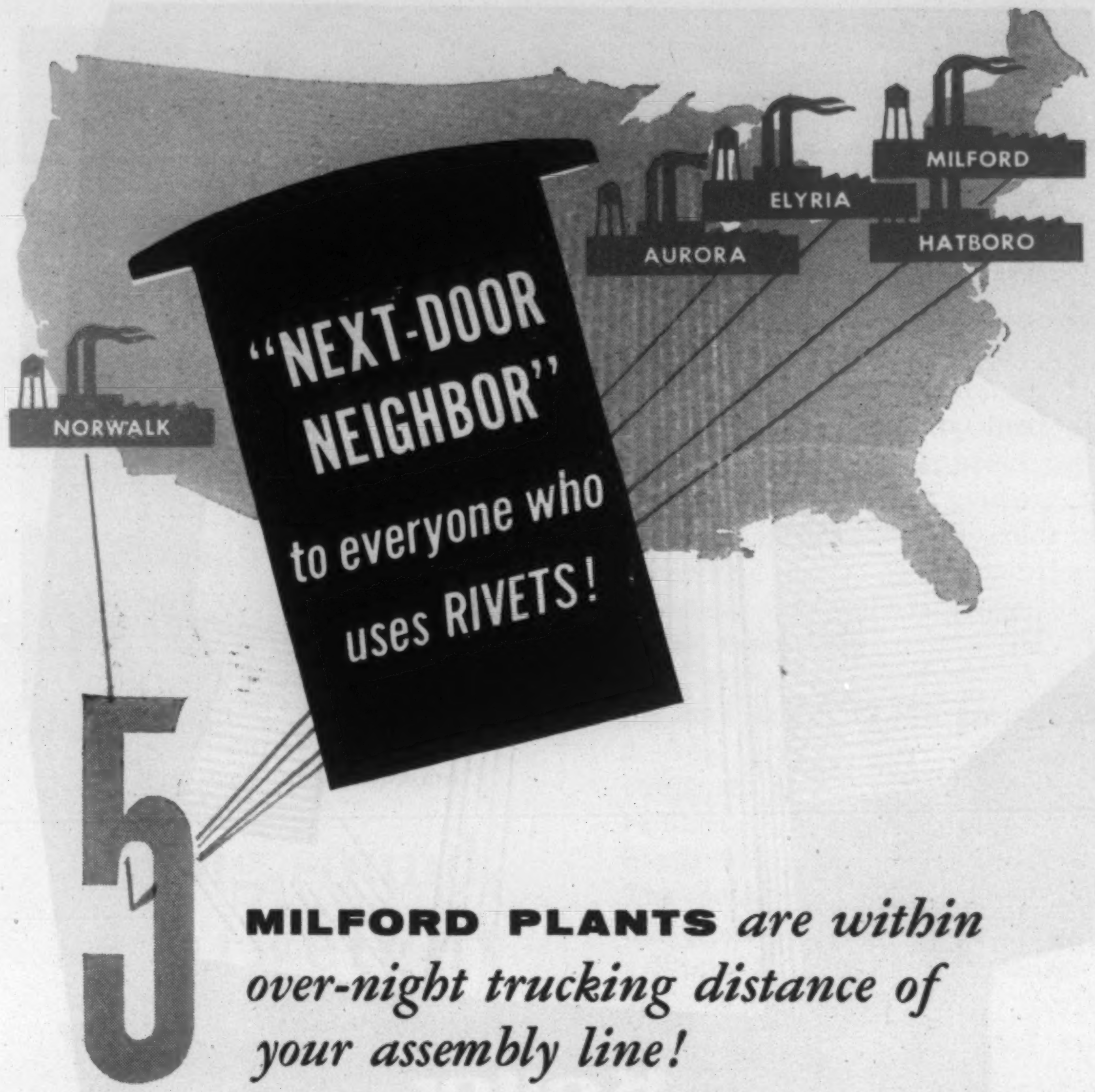
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quenched in oil from 1575 F and tempered at 1100 F for 2 hr had the following average properties:

Tensile str	126,700 psi
Yield str	115,200 psi
Elongation	2.5%
Brinell hardness	321

Copper-titanium alloy

Investigation of the heat treatment of cast copper-titanium alloys indicated that the mechanical properties of the alloy containing 6% titanium can be improved considerably by age hardening. N. Hehner, H. McCurdy and R. Edelman of Pitman-Dunn Laboratories, Frankford Arsenal, showed that the new alloy is stronger after heat treatment than cast manganese bronze but not as strong as cast beryllium copper. However, copper-titanium has the advantage that its aging temperature is about 200 F higher than that of beryllium copper, and it can therefore be used at higher operating temperatures without danger of overaging.

Optimum heat treatment for the copper-6% titanium alloy is a solution treatment at 1625 F followed by aging at 800 F. Average mechanical properties resulting from this treatment are: tensile strength 121,000 psi; yield strength (0.2% offset), 107,000 psi; elongation in 2 in., 8%; and reduction of area, 18%.

Aluminum casting alloy

A recently developed aluminum casting alloy, XA140, exhibits outstanding mechanical properties at temperatures of 400 to 600 F together with good casting characteristics. R. C. Lemon and W. E. Sicha, of the Alcoa Research Laboratories, discussed the properties of this alloy, which contains 8 copper, 6 magnesium, 0.5 manganese, 0.5% nickel, small additions of boron and titanium for grain refinement, and beryllium for oxidation resistance.

Tested at 600 F after 1000 hr at temperature, the new alloy has about twice the tensile strength and more than twice the yield strength of 142-T77 and A355-

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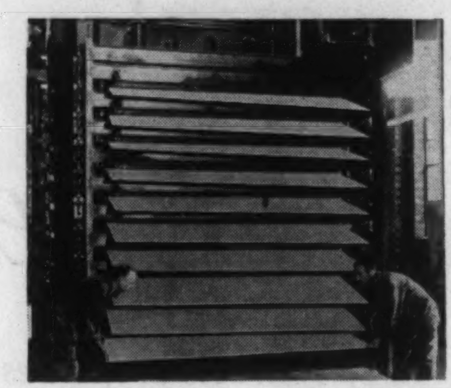
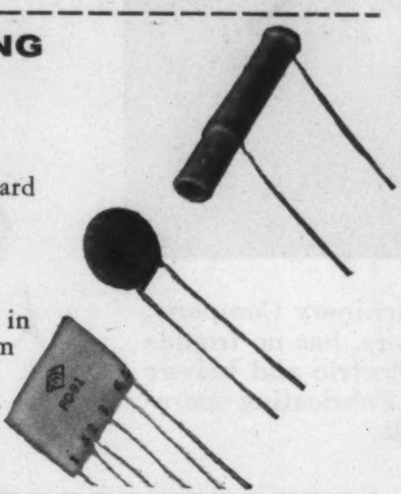
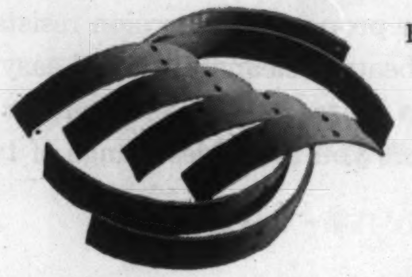
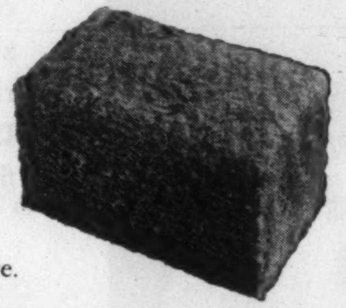
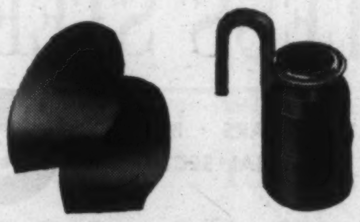

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...and for exceptionally high shock resistance, molding materials are bonded with Durez resin.

...do these suggest benefits for your business?

These examples suggest only a few of the many ways in which business is profiting from the characteristics of Durez phenolic resins. Their qualities of insulation, toughness, and resistance to extremes of temperature and humidity, and to attack by many acids and mild alkalies hold wide promise for investigation into profitable new uses. If your product or processes call for impregnants, bonds, coatings, or reinforcing agents, we may be able to help you. Our experience as leaders in the development and production of phenolics is at your service.

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T51, both standard alloys for service in the 400 to 600 F range. Limited tests indicate also that XA140 is superior in creep and stress rupture properties to other aluminum casting alloys at 400 F, but slightly inferior at 600 F. Fatigue strength at 400 and 600 F appears to be substantially higher than that of the other casting alloys.

Alloy XA140 is designed for service in the 400 to 600 F range in aircraft engines, particularly in gas turbine engines.

Conductivity of cast iron

Designers and engineers usually do not consider thermal conductivity when dealing with gray iron. Although it is common knowledge that the conductivity of gray iron is lower than that of carbon steel, thermal conductivity of iron is sufficient for most types of service in which it is employed. Generally, the engineer has little reason to worry about the differences in thermal conductivity among various grades of iron. However, in some applications, unless these differences are considered service failures may occur.

J. A. Davis, H. W. Deem and H. W. Lownie, Jr., of Battelle Memorial Institute, pointed out that the addition of almost any alloying element to gray iron will decrease its thermal conductivity, and a change from flake to spheroidal graphite causes an additional drop. In round numbers, some alloyed gray irons have only 65% and alloyed nodular irons only 50% of the thermal conductivity of unalloyed, flake type iron at 200 F.

Iron castings are used in many applications where one or more of the following conditions occur: 1) the flow of heat is unsteady or cyclic, 2) there is a fairly large difference in temperature between the hot and cold faces of the casting, and 3) there is a rapid transfer of heat to or from the iron. In such applications, thermal conductivity can have an important bearing on service life. For example, if the application is one

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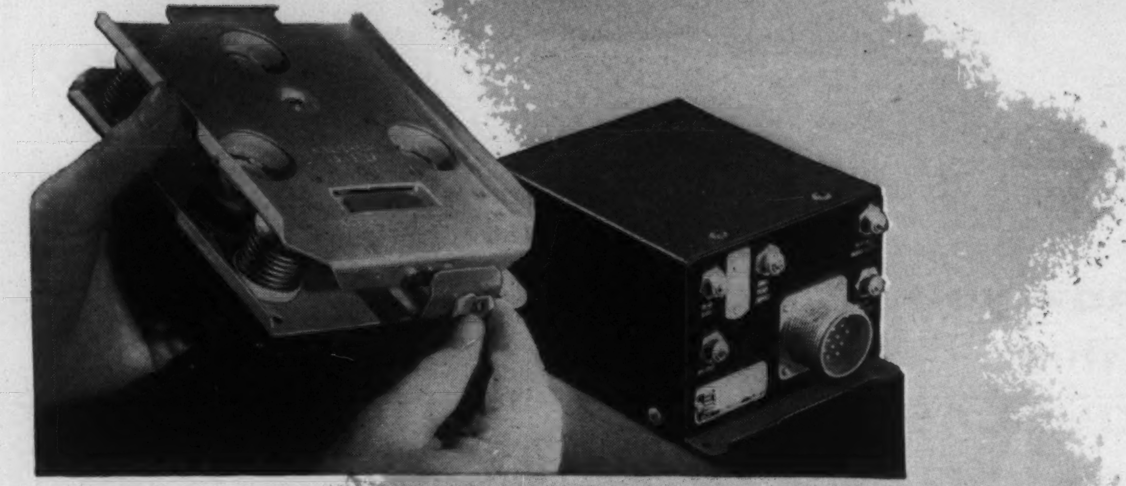
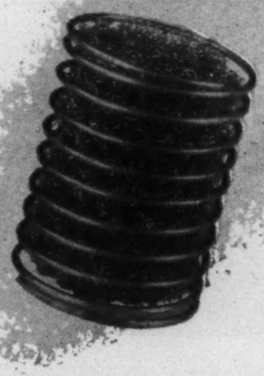
ALLOY WIRE

Cushions...



take the SHAKES out of

AIRCRAFT INSTRUMENTS



Fabricated all-metal mounts have high damping properties . . . Resist deterioration.

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When fabricated into a special pattern, the wire forms literally thousands of tiny interlocking springs. Their high damping characteristics and non-linear spring rate provide ample protection against dynamic overloads. Alloy wire resists deterioration by oil, water, ozone, bacteria, dust and extreme temperatures. Knitted alloy wire is used in hundreds of other industrial applications, such as filters, mist eliminators, electronic shielding. For further information send today for our Application Bulletin A-1.

ALLOY

ALLOY METAL WIRE DIVISION

HKP H. K. PORTER COMPANY, INC.
Prospect Park, Pennsylvania

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requiring the transfer of heat through the iron into a product, low thermal conductivity may result in a reduction of the useful heat supplied and the process may run cold. In an application in which it is desired to transfer heat through the iron to remove it from a hot face, such as in a brake drum, a lowered conductivity can increase the tendency of the heated face to heat check, oxidize, grow or warp.

By intelligent use of the higher strength of alloyed or nodular irons, it is sometimes possible to reduce the thickness of the casting wall and offset the effect of lower conductivity. Often, however, use of the thinner wall will nullify the advantage of using the stronger iron.

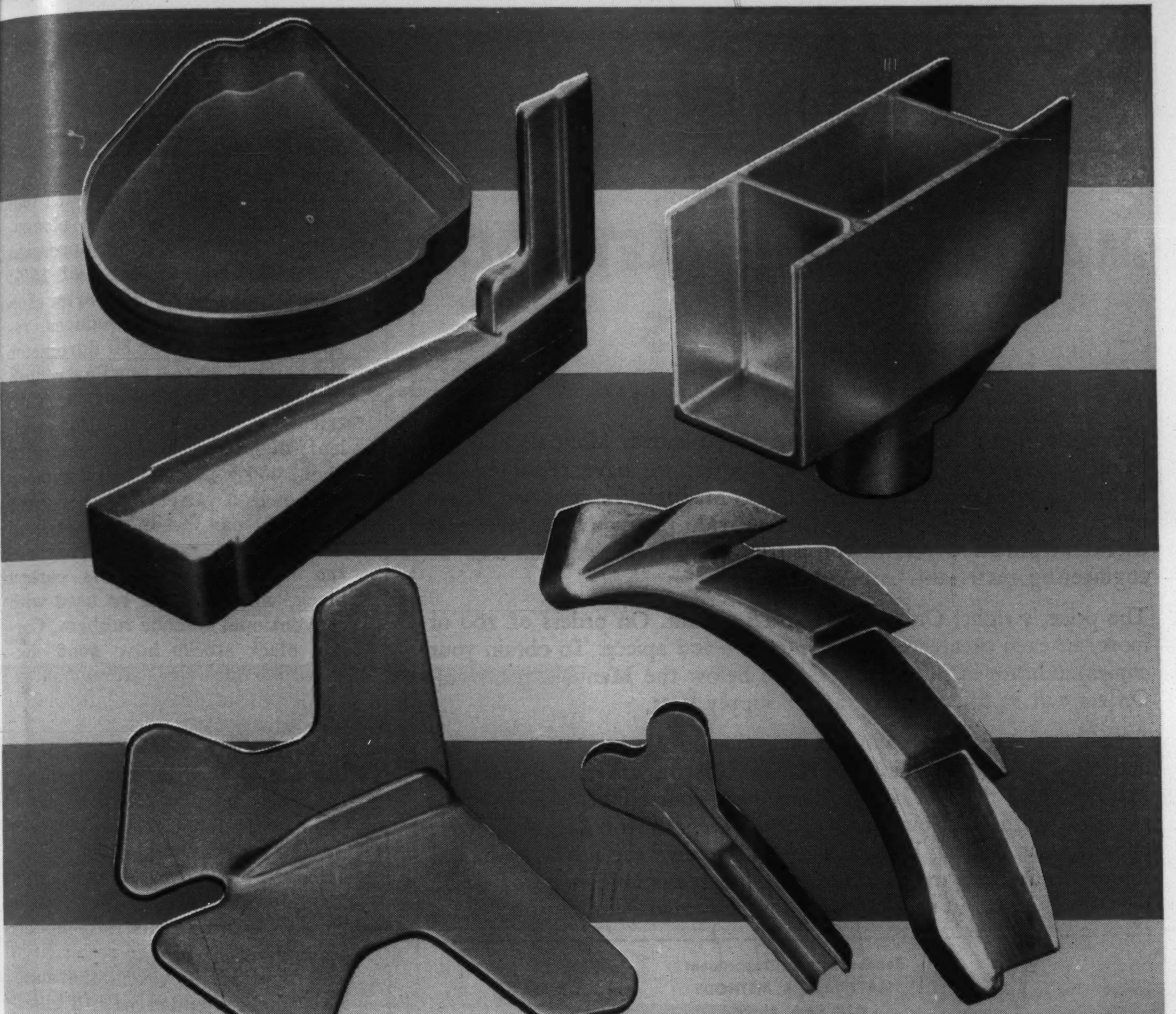
Vinyl-Silicone Rubbers Offer New Properties

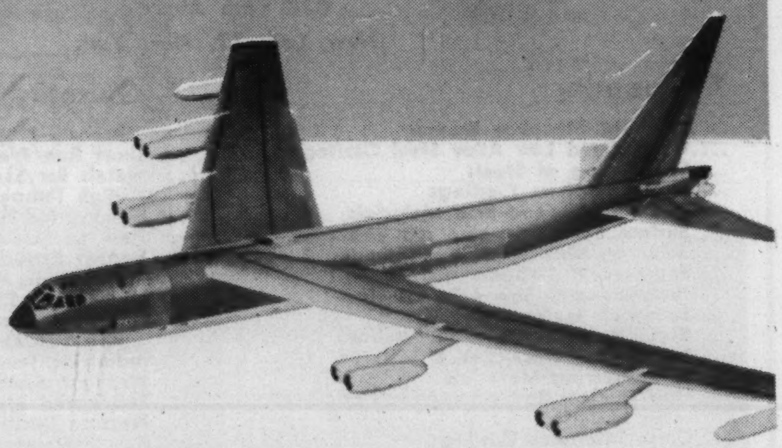
Addition of a specific proportion of vinyl groups in a silicone rubber gum imparts controlled reactivity (crosslinking capacity) to the material, which in turn widens the variety of fillers and catalysts that can be used in the compound. Judicious use of different fillers and catalysts can provide materials substantially different from conventional silicone rubbers.

In a paper delivered before the May annual meeting of the American Chemical Society's Rubber Chemistry Div. in Cleveland, J. H. Lorenz and M. L. Dunham, of Union Carbide's Silicones Div., described the properties and uses of vinyl-containing silicone rubber, specifically their company's W-96 gum. Initial information on this material was published in M&M, Oct '55, p 146. At that time, however, composition and the mechanisms involved were not disclosed.

Filler versatility

Conventional silica reinforcing materials can be used to provide a gum with low compression set. For example, 40 parts of silica in 100 parts of W-96 gum provides





No-draft forgings by Kaiser Aluminum

Kaiser Aluminum's Erie plant has been successful in meeting its customers' ever-growing needs for no-draft forgings.

Shown on this page are a few of the many no-draft forgings produced by Kaiser Aluminum on *existing equipment* for the aircraft industry.

Additional equipment—especially designed for no-draft forgings—will soon be installed to greatly increase our capacity for these specialized forgings.

Kaiser Aluminum no-draft forgings give you the benefits of substantial cost savings through the elimination of machining, plus extremely light weight with high strength, close tolerances, and superior finish.

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For immediate service, call any Kaiser Aluminum sales office listed in your local telephone directory. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Building, Chicago 11, Illinois; *Executive Office*, Kaiser Building, Oakland 12, California.

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a 50 durometer material with tensile strength of 850 psi, elongation of 230%, and compression set after 22 hr at 350 F of 15%. Adding 15, 30 or 45 parts of a diatomaceous earth produces, respectively, 60, 70 or 80 durometer stocks with 900 psi tensile strength and 10-15% compression set. Electrical properties are also excellent, dielectric strength values of about 500 v per mil being typical.

Though a variety of other types of fillers can be incorporated in this type of gum stock, perhaps the most interesting is carbon black, which cannot be used with conventional silicone rubbers. Carbon black stocks have good electrical conductivity without an excessive sacrifice of mechanical strength.

A typical example is a carbon black-filled, conductive silicone rubber compound, X-1516, developed by Union Carbide. The 60-durometer material has tensile strength of 840 psi, elongation of 210% and tear strength of 50 lb per in. Volume resistivity is only 35 ohm-cm; if higher resistivities are required, however, the material can be blended with a silica-filled W-96 compound. High temperature stability of carbon filled stock is comparable to that of silica filled stocks. ASTM No. 1 oil resistance is excellent (10% volume swell after 70 hr at 350 F).

Catalyst variety

One of the most striking things about the so-called controlled reactivity gums is the small amount of catalyst required for cure, since the catalyst is used with optimum efficiency at crosslinking sites. This decrease in amount of catalyst used results in improved physical properties since there are less decomposition products, such as acids, aldehydes and water, concentrated in the material during cure.

With vinyl-containing gums, ditertiary-butyl-peroxide (DTBP) can be used as a catalyst. It can be used only with this type of silicone rubber since it crosslinks only where vinyl groups are pres-

Why Armco ALUMINIZED STEEL Type 2 lengthens product-life in outdoor service

In commercial production only one year, Armco ALUMINIZED STEEL Type 2 already is proving itself in many kinds of outdoor service.

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The life of the aluminum coating in outdoor service is at least 3 times that of a standard zinc coating on galvanized steel sheets.

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Many products have been improved by ALUMINIZED STEEL Type 2 in its first year of service. A few are listed here. Check the list. Perhaps you make similar products that could be improved by the extra strength and atmospheric corrosion resistance of this new Armco Steel. It is produced in sheets and sheet coils, 14 to 24 gage.

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- Awnings and Supports
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Let us send you complete information about this new Armco Steel for outdoor service. Just fill in and mail the coupon.

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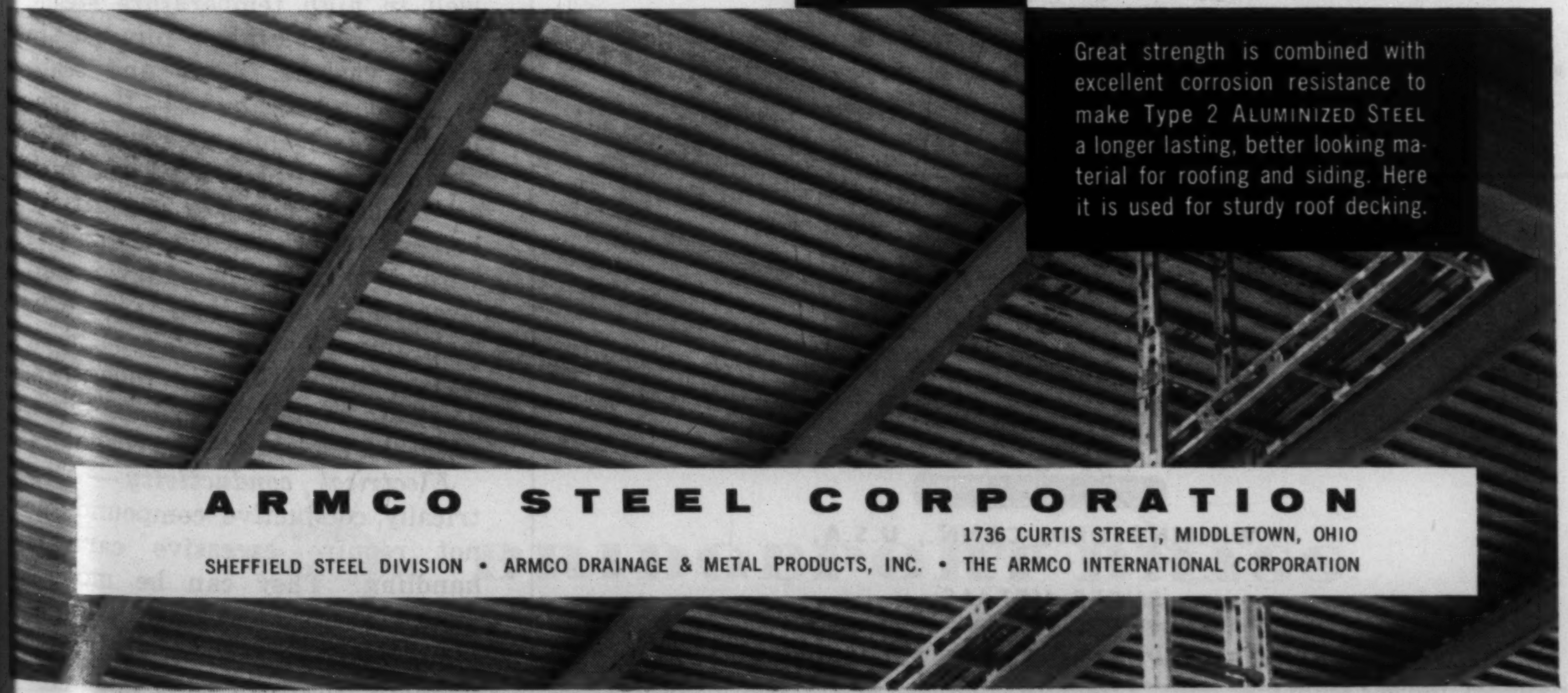

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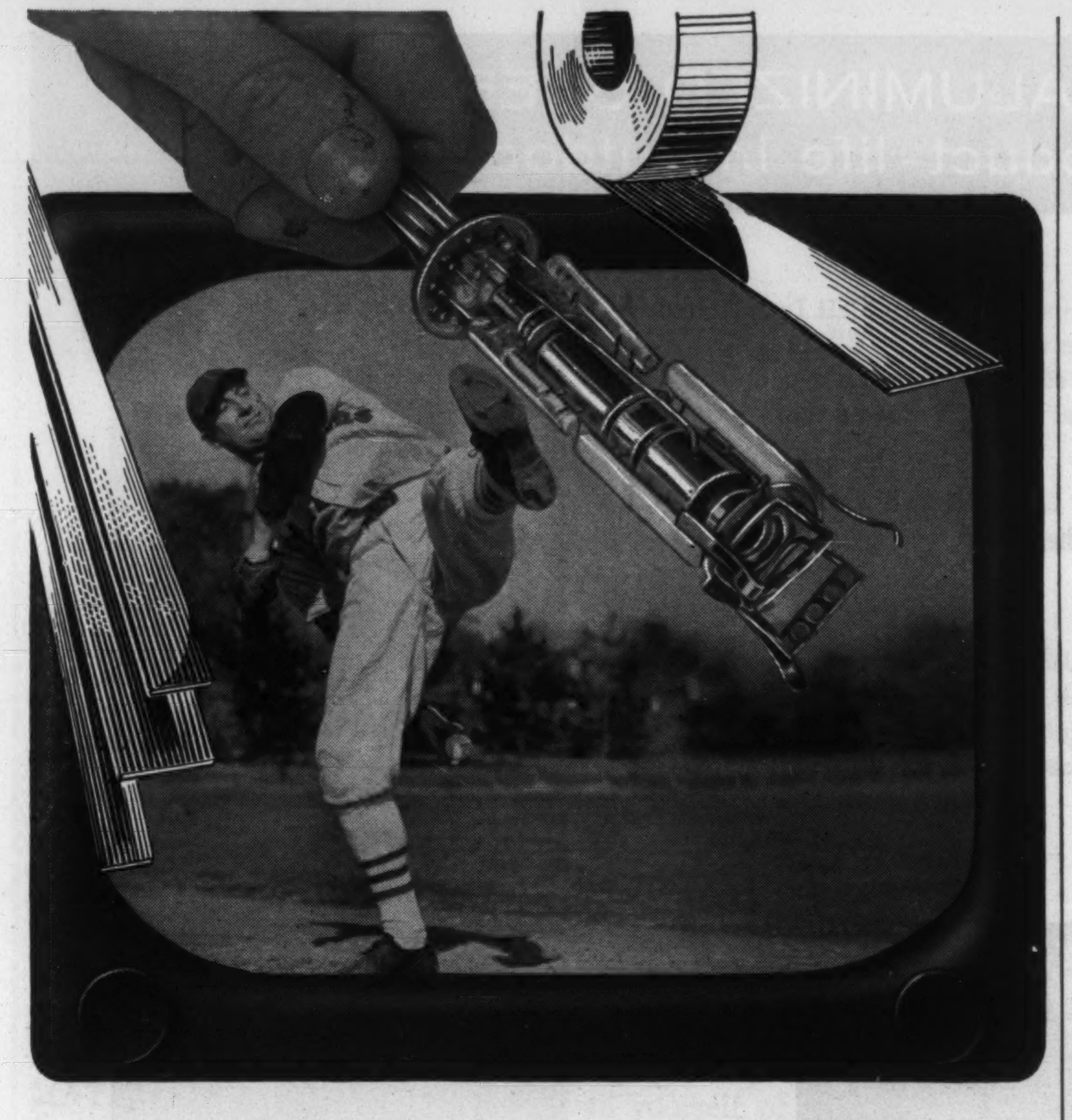

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This electron gun generates the pencil-like electron beam, or "paint brush," which sweeps across the fluorescent face of your television tube to "paint" the picture.

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ent. Use of this catalyst permits thick section parts to be fabricated and post-cured immediately at 480 F without sponging, depolymerizing or delaminating. Also, since the free radicals needed for crosslinking are not available in this type of system until a temperature of 285 F is reached, multi-cavity molds can be charged hot without danger of cure starting before flowout.

Though DTBP requires careful care when handled alone (it has a flash point lower than 80 F), use of special compounds (DTBP is locked in the compound in a state of low volatility and reactivity until cure temperature is reached) can eliminate processing hazards.

A variety of catalysts in addition to DTBP can be used to cure vinyl-containing silicone rubbers. Selection of catalyst depends on the type of processing to be done, and the type of item to be made.

Applications

The properties obtainable in vinyl-containing silicone rubbers make them particularly well suited for the following types of applications or service:

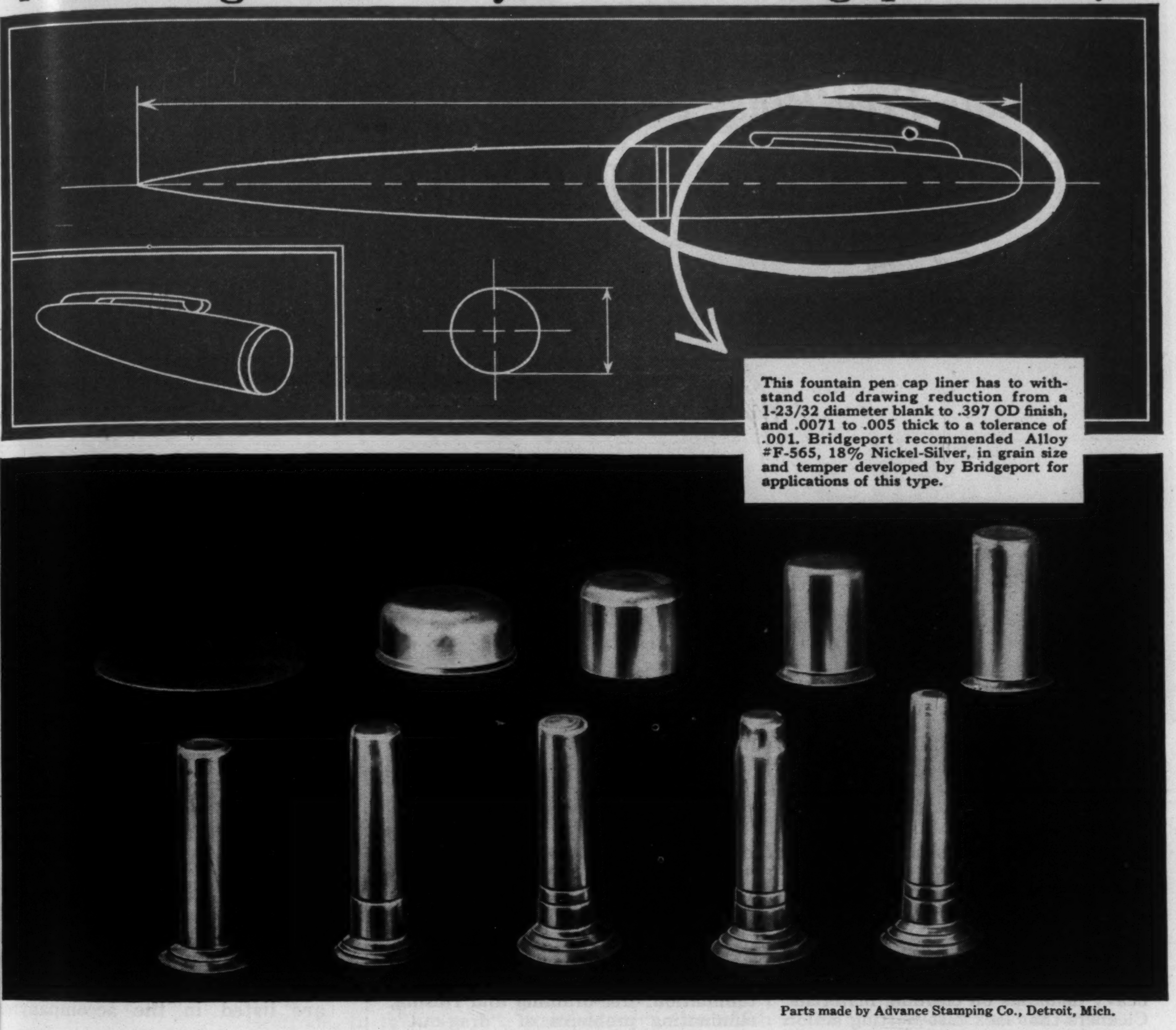
Rolls—Ability to cure in thick sections makes these materials well suited for use in rubber-covered rolls for the graphic arts, paper, plastics, textile, glass and metalworking industries.

Steam—The material stands up well in high temperature steam, making it suitable for use in steam gaskets, hoses and seals.

Low compression set—Hot compression set values as low as 15%, obtainable without additives such as oxides of mercury, permit the benefits of these characteristics without the hazards of toxic additives. This advantage is particularly important in the food, drug and pharmaceutical industries. Typical products are O-rings, push-rod seals and fin separators.

Electrical conductivity—Electrically conductive compounds do not require excessive care in handling. They can be molded, calendered or extruded without appreciably changing their low

Matching metal to job with Bridgeport alloys



This fountain pen cap liner has to withstand cold drawing reduction from a 1-23/32 diameter blank to .397 OD finish, and .0071 to .005 thick to a tolerance of .001. Bridgeport recommended Alloy #F-565, 18% Nickel-Silver, in grain size and temper developed by Bridgeport for applications of this type.

Parts made by Advance Stamping Co., Detroit, Mich.

For better stamping, drawing, cold forming...

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Let Bridgeport match the metal to the job! Tell us your requirements—both working and service properties—and our Technical Service will be glad to recommend the right Bridgeport High I.Q. alloy for the job. The right alloy may help you cut production costs and produce a better product. Call your Bridgeport sales office today for a metal recommendation to fit your specific needs.

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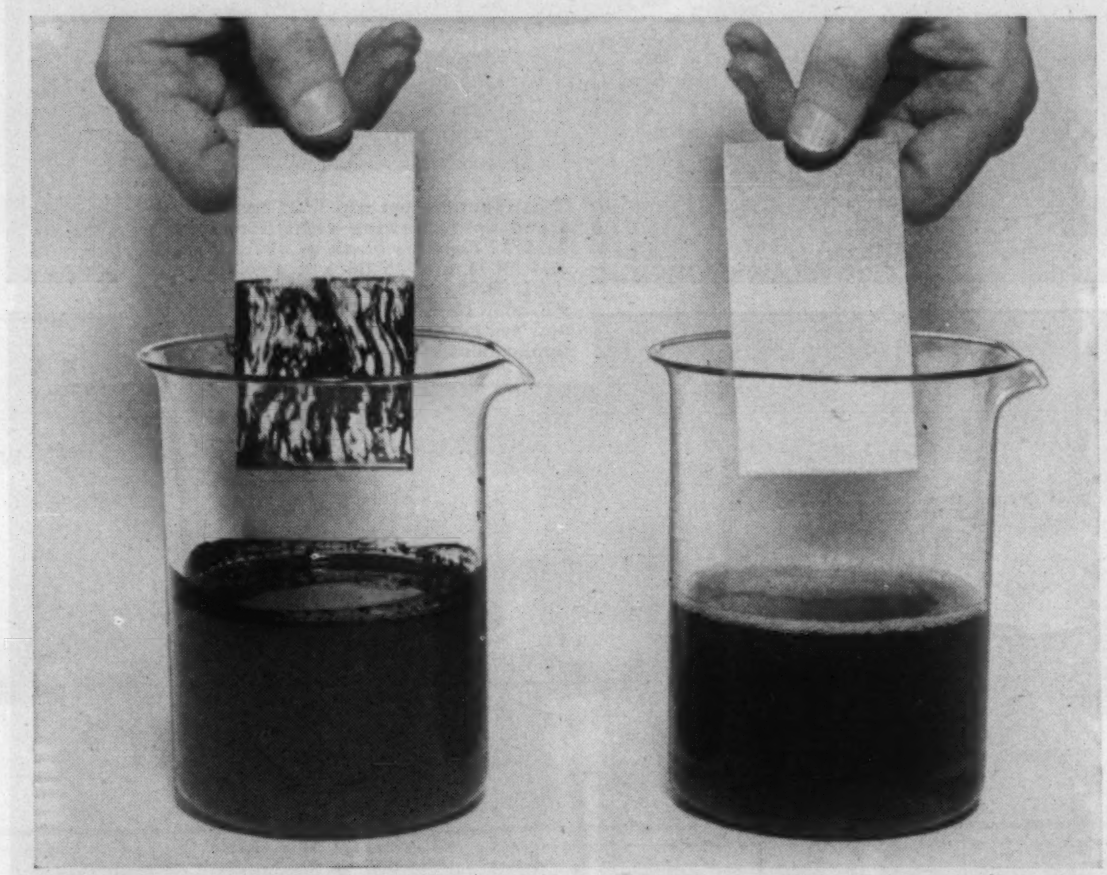
Pre-cleaning
for Automatic
Plating Lines

How Free-Rinse Process

CUTS COSTLY REJECTS



WHY YOU MAY BE GETTING TOO MANY REJECTS. *Difference in rinsing properties of two cleaners is clearly shown above. Beaker at left contains a conventional cleaner in general use. Beaker at right contains a solution of Diversey No. 909 Heavy Duty Cleaner. Identical amounts of grease and dirt are added to each beaker. Notice how soil clings to metal strip inserted in conventional cleaner, while work dipped in Diversey No. 909 at right is clean, free of waterbreaks.*

Automatic plating lines put unusually heavy demands on cleaning materials. Cleaners that lack fast wetting action can't do a thorough cleaning job within the fixed limits of the automatic cycle. Cleaners that lack free-rinsing properties will cause "drag-out" that contaminates other tanks and causes rejects. Many cleaners lack capacity to hold large amounts of contamination, which means frequent shutdowns of the line to dump solution. Unstable cleaners cause constant adjustment and titration problems.

To meet the strict demands for cleaning in automatic lines, The Diversey Corporation has developed a series of cleaners that eliminate these serious problems and produce far superior results at lower overall costs. The Diversey process includes the following recommended cleaners for the important steps in the cleaning cycle:

For pre-soaking: Diversey #909 Heavy Duty Cleaner. Advantages—faster wetting action which means that cleaning starts sooner; longer solution life due to high capacity for holding contamination; free-draining and rinsing, eliminating problems of "drag-out"; non-caustic, safe to handle.

For electro-cleaning: Diversey #12 Electro-Cleaner. Advantages—faster acting due to excellent current-carrying capacity; controls foaming, thus reducing explosion danger caused by build-up of gas under heavy foam blankets.

For spray-cleaning: Diversey #519 Spray Cleaner. Advantages—faster wetting action, better emulsification; long solution life; free rinsing without waterbreaks; non-caustic.

Your nearby Diversey D-Man will be glad to demonstrate how the Diversey process will give you (a) superior cleaning, (b) easier and more effective control due to the uniformity of solutions, (c) longer runs without shutdowns. For free illustrated brochures on Diversey metal cleaners, write today on your letterhead to Metal Industries Department, The Diversey Corporation, 1820 Roscoe St., Chicago 13, Illinois.

For more information, turn to Reader Service Card, Circle No. 522

CONTENTS NOTED

volume resistivity (5 to 50 ohm-cm). The combination of conductivity with high temperature stability has led to use in heater pads for aircraft cameras, hospital tubing and shielding for electrical equipment operated at high temperatures.

Solvent resistance—The vinyl-containing gums exhibit better oil and solvent resistance than dimethyl gums, making them suitable for applications such as brake cups, transmission seals and other similar hot sealing applications.

Aluminum-Zinc Alloy Developed for Castings

A new foundry alloy of the aluminum-zinc type is being produced commercially in France. This alloy, which was developed for the production of sand and permanent mold castings, attains its maximum properties by natural aging or by a simple normalizing treatment. Properties are discussed by Charles Roinet in an article appearing in the February issue of *Revue de L'Aluminium* (French).

Composition of the alloy is 4.5 to 5.5 zinc, 0.15 to 0.35 copper, 0.4 to 0.65 magnesium, 0.15 to 0.25 titanium, and 0.15 to 0.35% chromium. Mechanical properties are listed in the accompanying

MECHANICAL PROPERTIES

	Yld str, 0.2%, 1000 psi	Ten str, 1000 psi	Elong %
Sand cast[a]			
as cast	18–23	28–36	5-9
normalized at 350 F	20–24	28–31	5-8
aged 1 mo at rm temp	23–26	33–36	7-9
Permanent mold cast[b]			
as cast	20–23	34–40	10-15
normalized at 350 F	22–24	31–36	8-13
aged 1 mo at rm temp	23–27	36–40	11-15

[a] Brinell hardness: 60-70

[b] Brinell hardness: 65-75

Gain 99% More Production Time... *with Sigma Welding*

Steel gussets, ⅝-in. thick are sigma welded to ⅞-in. thick drum ends at an average speed of 15-in. per minute.

This welding operator doesn't have to bother with fluxes—and he doesn't lose valuable time changing burned down electrodes. In fact, by using sigma welding in this operation, the Cardwell Manufacturing Company, Wichita, Kansas has increased welding speed and almost doubled arc time. The results—a better product, faster, and at less cost.

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Sigma welding uses a welding wire, supplied from a convenient sized coil, as a consumable electrode. In this case it is stainless steel wire which is fed automatically, and at a predetermined rate, into the welding arc. This ups welding speeds and simplifies work.

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The arc is maintained in a shield of argon gas which envelopes the area between welding wire and work piece. Inert gas protection assures highest weld quality, and further simplifies welding operations.

Sigma welding is available in both manual and mechanized setups. Call or write your local LINDE representative for free illustrated literature, and find out how you can gain new production speed and unit quality with a sigma welding installation.

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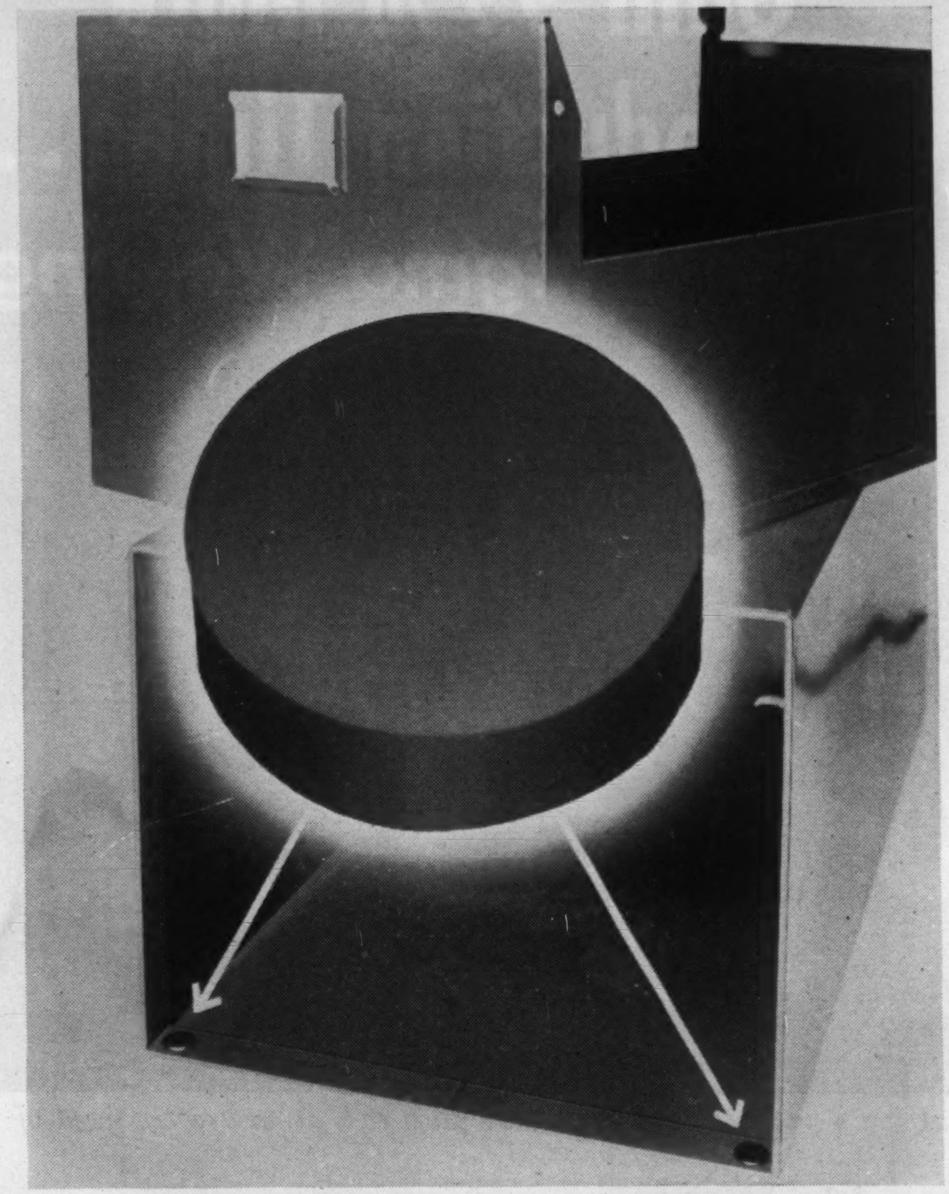

Sintered Nylon Discs Now Provide Exceptionally Long Wear and *Smooth, Quiet Action*

• Test apparatus in the manufacturer's research laboratories opened and closed a fully loaded storage file drawer riding on these graphite filled, sintered nylon discs 30,000 times with no measurable wear. Previously tested unfilled, injection molded nylon wore 1/32" after only 10,000 cycles.

NYLASINT parts are formed from specially processed, finely divided nylon powders by a patented method of high speed cold pressing and oil sintering. This powder can be supplied with various inert filler materials (i.e.—graphite, molybdenum disulphide) to provide superior properties for bearings, bushings, cams, gears and rollers.

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A Subsidiary of The Polymer Corporation, Reading, Pennsylvania

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table. This alloy differs from many of the usual aluminum casting alloys in showing little variation in properties between test bars taken from the casting and those cast separately. In addition, little change in composition and structure occurs in successive melting and casting operations.

Immediately after casting, the alloy is sufficiently ductile to permit moderate forming operations. Machinability is similar to that of other aluminum foundry alloys. The alloy can be brazed and can be joined by all welding methods applicable to aluminum. Mechanical polishing produces a surface finish comparable with that of aluminum-magnesium alloys, and the alloy can be readily oxidized by anodic treatments to produce an attractive, uniform finish.

Silver Aids Welding of Aluminum to Copper

Aluminum bus bar, now being used widely, can usually be connected to copper by properly designed bolted joints. However, when elevated temperatures are encountered a welded joint is required to insure good service.

L. A. Cook and M. F. Stavish, of Kaiser Aluminum & Chemical Corp., describe a welding method for producing such joints in the April issue of *The Welding Journal*. The portion of the copper to be joined to aluminum is coated with a silver solder, using standard silver brazing procedures. The aluminum and coated copper are then welded by standard consumable electrode inert-gas metal arc welding methods. Purpose of the silver solder is to serve as a buffer layer to prevent excessive formation of brittle copper-aluminum compound ($CuAl_2$) during welding.

Mechanical, electrical and metallurgical characteristics of the joints are satisfactory.

(Books on p 190)

what
ALL-STAINLESS
design means to horizontal plate filters...

Crucible stainless steel, type 304, is used throughout this Sparkler standard horizontal plate filter.

Constant filtration of chemicals, pharmaceuticals, foods and liquids subject this horizontal plate filter to pretty rugged corrosive, abrasive and temperature conditions. That's why Sparkler Manufacturing Co. uses all-stainless steel construction.

For stainless, first of all, fights off corrosive attack. And it's strong. Stainless becomes tougher the more it's used . . . which is another way of saying that, with stainless, abrasion is no problem. And neither is cleaning. For stainless steels' smooth, bright surface comes clean with a minimum of effort . . . stays clean longer.

The fact is, stainless makes any equipment stronger, longer-lasting, easier to use. Check with your local Crucible representative for help in selecting the best stainless grade for your job. Or write *Crucible Steel Company of America, The Oliver Bldg., Mellon Sq., Pittsburgh 22, Pa.*

CRUCIBLE **first name in special purpose steels**

Crucible Steel Company of America

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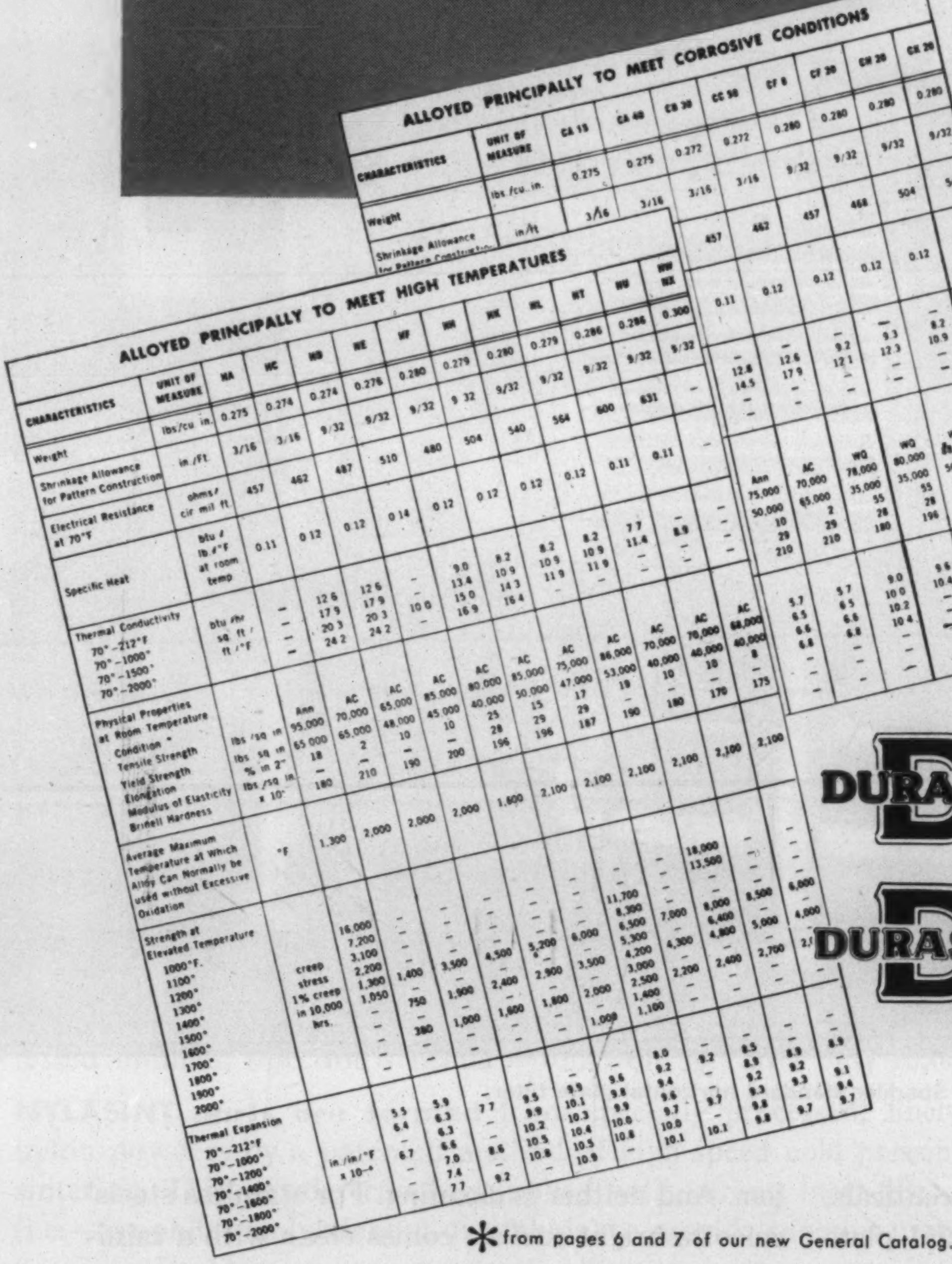
* TABLES to help you select the proper alloy for your casting specs


ALLOYED PRINCIPALLY TO MEET CORROSIVE CONDITIONS
ALLOYED PRINCIPALLY TO MEET HIGH TEMPERATURES

DURALOY

DURASPUN

* from pages 6 and 7 of our new General Catalog. No. 3354-G

— and there's lots more useful information about high alloy castings in our up-to-date catalog describing Duraloy Service. SEND FOR YOUR COPY.

As one of the pioneers in both static (1922) and centrifugal (1931) high alloy castings, we have a wealth of experience to focus on your high alloy casting problem. Send for our catalog, study it, and then let us help you get the best alloying combination to solve your corrosion, high temperature and/or abrasion problem.

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For more information, turn to Reader Service Card, Circle No. 467

CONTENTS NOTED

BOOKS

The Control of Quality in the Production of Wrought Nonferrous Metals and Alloys. III.—The Control of Quality in Heat-Treatment and Final Operations. A Symposium Held in London on 31 March 1955. *The Institute of Metals, London, S.W. 1, England. 1955. Cloth, 8¾ by 11½ in. 104 pp. $2.50.*

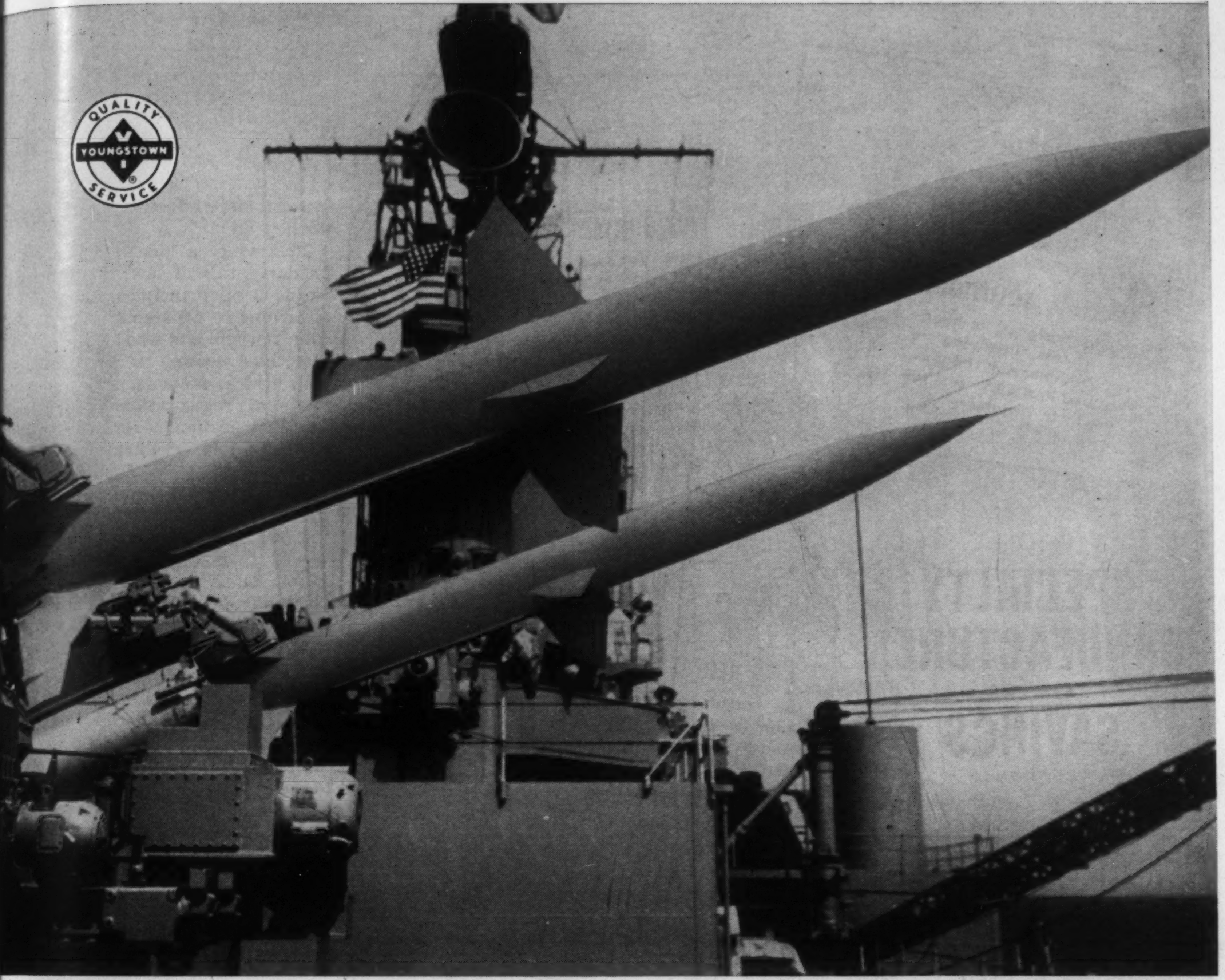
A reprint of six papers presented at the symposium and a general discussion of these papers. Included are "Assessment of Quality of Wrought Products," "The Control of Quality in Heat-Treatment and Final Operations in the Production of Rolled, Extruded, and Drawn Aluminium and Aluminium Alloys," "Heat-Treatment and Finishing Operations in the Production of Copper and Aluminium Rod and Wire," "The Control of Quality in the Heat-Treatment and Finishing of Copper and Copper-Base Alloys," "The Production of Light-Alloy Drop-Forgings, Their Heat-Treatment, Inspection, and Testing" and "The Heat-Treatment, Inspection, and Testing of Wrought Nickel and Nickel Alloys."

Resistance of Materials. *Fourth Edition. Fred B. Seely and James O. Smith. John Wiley & Sons, Inc., New York 16, N. Y. 1956. Cloth, 5¾ by 8¾. 459 pp. Price $6.50.*

This fourth edition, essentially a new book, is intended, as were previous editions, for use as a first course for engineering students and young engineers already in practice. In the selection and organization of the topics, the authors have tried to make the theory of resistance of materials more self-sufficient and to develop more logical methods of analysis and design. A large number of new problems and figures have been added, many of which emphasize actual physical conditions met in engineering practice. The authors are both with the University of Illinois.

Legal Problems in Engineering. *Melvin Nord. John Wiley & Sons, Inc. New York 16, N. Y. 1956. Cloth, 6 by 9¼ in. 391 pp. Price $7.50.*

The author, who was formerly professor of chemical engineering at Wayne University, is now a consultant in legal and engineering problems, a patent engineer and a contributor to patent review departments in several engineering journals. His book is designed for use and reference for engineers. Although it does not pretend to make an engineer independent of lawyers, it is intended to help him to avoid legal problems before they arise and



Official U. S. Navy Photograph

Supersonic tracker of enemy planes

Now guarding our coast, U. S. Navy's new guided missile has vital parts of Youngstown Alloy Sheets

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The Youngstown Sheet and Tube Company is proud of participating in the production of high quality steel used in these new weapons for our naval forces.

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CASE HISTORY 1

REQUIRED:
A dependable supply of this small, machined electrode to meet customer's quality and quantity needs at reduced cost.

HASSALL SOLUTION:
Hassall-designed re-heading process, involving no critical dimension changes, resulted in a 59% cost reduction to customer.

CASE HISTORY 106

REQUIRED:
Replacement for stud with insufficient head to act as stop for automatic hammering.

HASSALL SOLUTION:
Substitution of Hassall cold-headed collar stud with annular threads for greater holding power. Substantial cost savings.

SPECIALTY MANUFACTURER OFFERS SAVINGS ON SMALL PARTS AND FASTENERS

CASE HISTORY 64

REQUIRED:
An economical method of manufacturing perforating punches out of hard materials such as drill rod.

HASSALL SOLUTION:
The Hassall cold-heading process plus engineering skill overcame the difficulties presented by these alloys at considerable savings.

Multiply these case histories a thousandfold and you'll get some idea of the variety of tough problems we crack, and the savings we effect for our customers in the course of a year.

Our cold-heading process—supplemented by secondary operations—imposes amazingly few limitations on the parts and fasteners we can make. Don't forget that we are not limited to "stock" sizes. These illustrations show that Hassall—a specialty supplier—can show you substantial savings, better deliveries and technical assistance on your small parts and fasteners.

Proof? Send us your specifications or write for catalog.

John Hassall, Inc., P. O. Box 2174 Westbury, Long Island, New York.

CASE HISTORY 37

REQUIRED:
Bumper bolt with bonded rubber cap for license plate support.

HASSALL SOLUTION:
The large head on this bolt would ordinarily call for screw machining but the two lugs under the head ruled this out. Progressive cold-heading was Hassall's answer.

HASSALL

SINCE 1850

SPECIAL NAILS RIVETS SCREWS
Hassall

NAILS, RIVETS, SCREWS AND OTHER COLD-HEADED FASTENERS AND SPECIALTIES

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to work more effectively with lawyers if they do.

Following a discussion of basic fundamentals of law, the author explains legal principles and their applications to contracts, sales, negotiable instruments and other matters. The third section of the book deals with ethical responsibilities and professional registration of engineers. The last section covers construction contracts and specifications; governmental regulation of business; patents, copyrights and trademarks; and air and stream pollution.

Cases are presented in a condensed form to illustrate discussion and to point up legal problems that may be encountered. There is a minimum of legal jargon.

American Welding Society Recommended Practices. *The American Welding Society, Inc., New York 18, N. Y. 1955.*

Metallizing Flat Surfaces. *Paper. 10 pp. Price 50¢.*

Recommended Practices for Interruption of Heat Treatment Cycles for Low Chromium-Molybdenum Steel Piping Materials. *Paper. 4 pp. Price 50¢.*

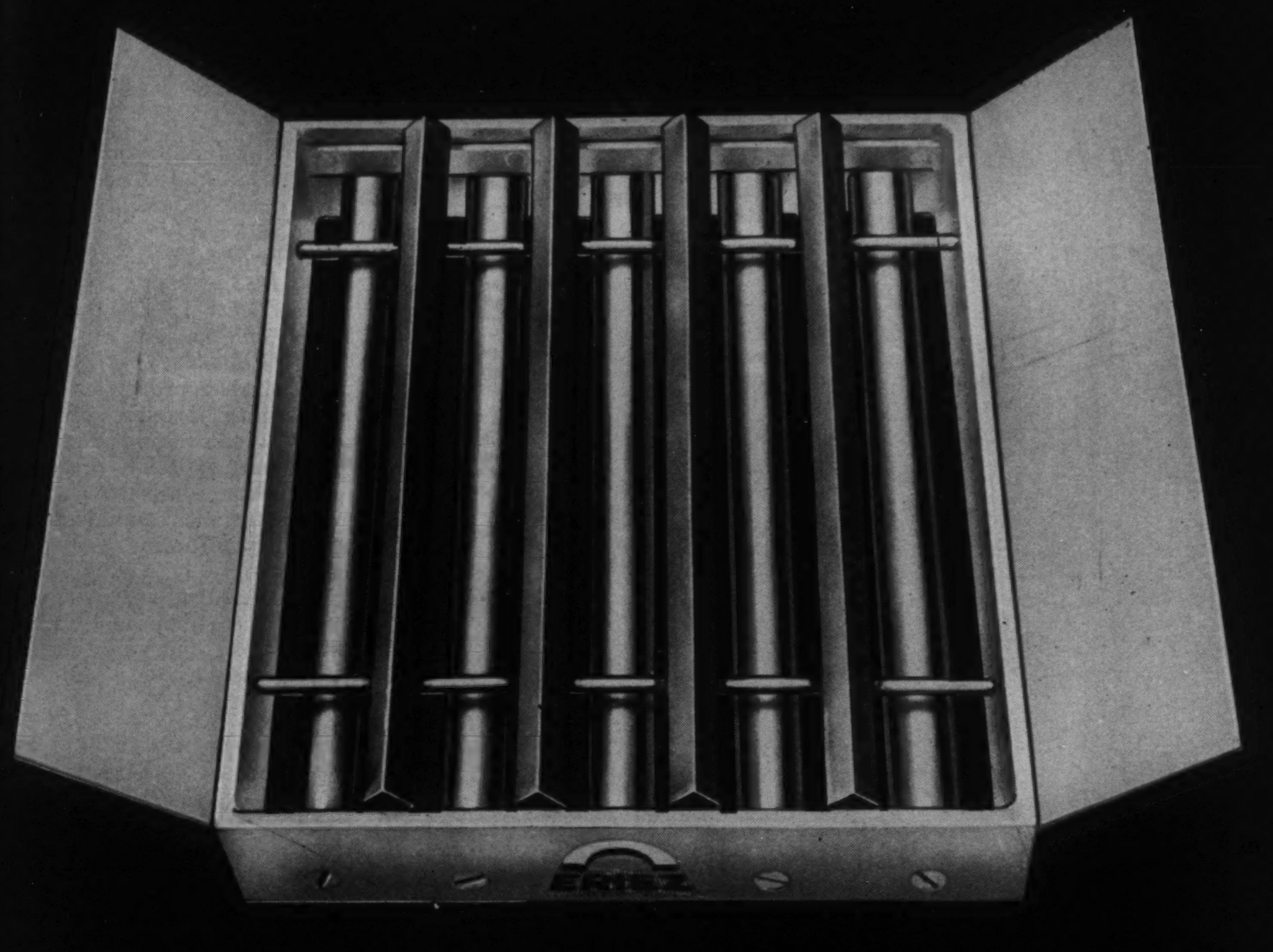
The Welding of Austenitic Chromium-Nickel Steel Piping and Tubing. *Paper. 25 pp. Price $1.00.*

The Surface Treatment and Finishing of Aluminum and its Alloys. *S. Wernick and R. Pinner. Robert Draper Ltd., Teddington, Middlesex, England. 1956. Cloth 6 by 9 in. 554 pp. Price $12.00, postpaid.*

A comprehensive and up-to-date discussion of all available processes for the surface treatment and finishing of aluminum and its alloys. It is based on a text first published in the British journal, *Sheet Metal Industries*, and later revised for publication in this country.

The book is conveniently arranged and includes the well known protective and/or decorative finishes, such as anodizing, dyeing and electrodeposition, together with conversion coatings and other treatments preparatory to specialized finishing procedures. Chapters on mechanical surface treatments and finishes, electrolytic and chemical polishing, cleaning, hard anodizing, hard chromium plating, organic finishing, vitreous enameling and metal spraying are also included. There are 104 tables and 189 figures. The appendix compares composition and properties of major British and U.S. aluminum alloys.

(Reports on p 194)



TRENTWELD stainless tubing shown in Permanent Non-Electric Grate Magnet produced by Eriez Manufacturing Company, Erie, Pa.

how TRENTWELD stainless tubing traps "tramp iron" in product flow...

As free-flowing products such as chemicals, grains, sugar or spices flow through this separator unit, large and small iron contamination is seized by powerful magnets and held firmly to the five stainless steel tubes.

This is a unit that's normally given long, hard use. That's why TRENTWELD stainless steel tubing is chosen to house the Alnico V magnetic elements. For stainless resists abrasion and corrosion . . . its smooth surface offers a minimum of resistance to product flow . . . and stainless is strong—lasts indefinitely. What's more, stainless is the easiest of metals to keep clean and sanitary.

And equally important to you is the fact that TRENTWELD is made by *tube mill specialists*—by the new, patented *Contour-Weld** Process. That means stainless pipe or tubing with a smoother I.D., free from any weld bead or undercut.

So when you need stainless or high-alloy pipe or tubing, make sure it's TRENTWELD. You can't buy better!

***Contour-Weld is the trade mark of the Trent Tube Company for its processes of welding pipe and tubing which is protected under U. S. Patent 2,716,692.**

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TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of CRUCIBLE STEEL COMPANY OF AMERICA)

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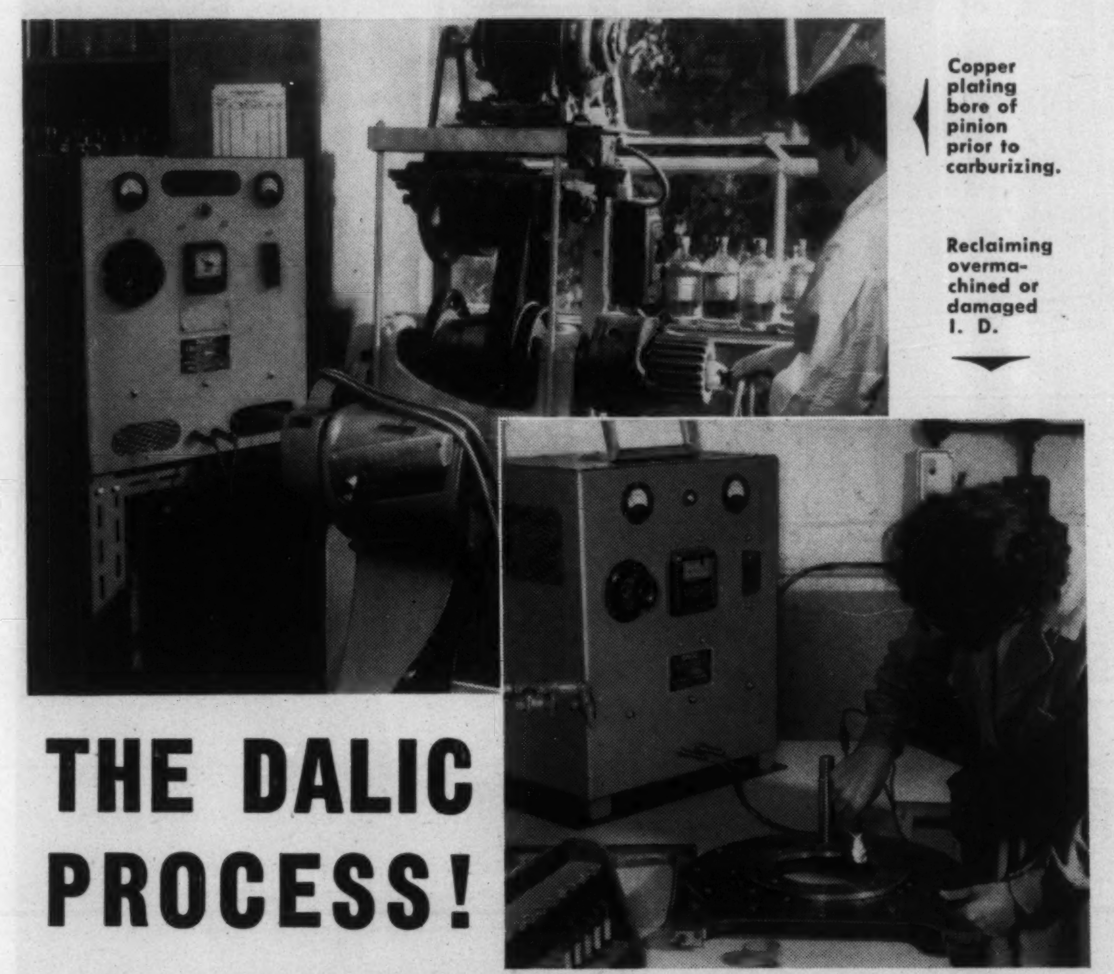
DALIC
in Industry



Copper plating bore of pinion prior to carburizing.

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CONTENTS NOTED

REPORTS

Fluorine compounds Evaluation of Organic Fluorine Compounds for Use in Military Aircraft. *Harold Rosenberg and J. C. Mosteller. Wright Air Development Center. Apr 1955. 22 pp. tables. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. 75¢. (PB 111983)*

Desirable properties of fluorine-containing organic compounds include wide liquid range, unusual chemical stability, good electrical conduction, desirable heat transfer characteristics and decreased flammability. Fluorine compounds have, accordingly, been studied for use as fire-extinguishing agents, acid resistant coatings and greases, nonflammable hydraulic fluids, elastomers, electronic equipment and fungicides.

Fluorinated polyethers Fluorine-Containing Polyethers. *Ogden R. Pierce, Donald D. Smith and Robert M. Murch, Dow Corning Corp. June 1955. 57 pp, dwg., graphs, tables. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. $1.50. (PB 111986)*

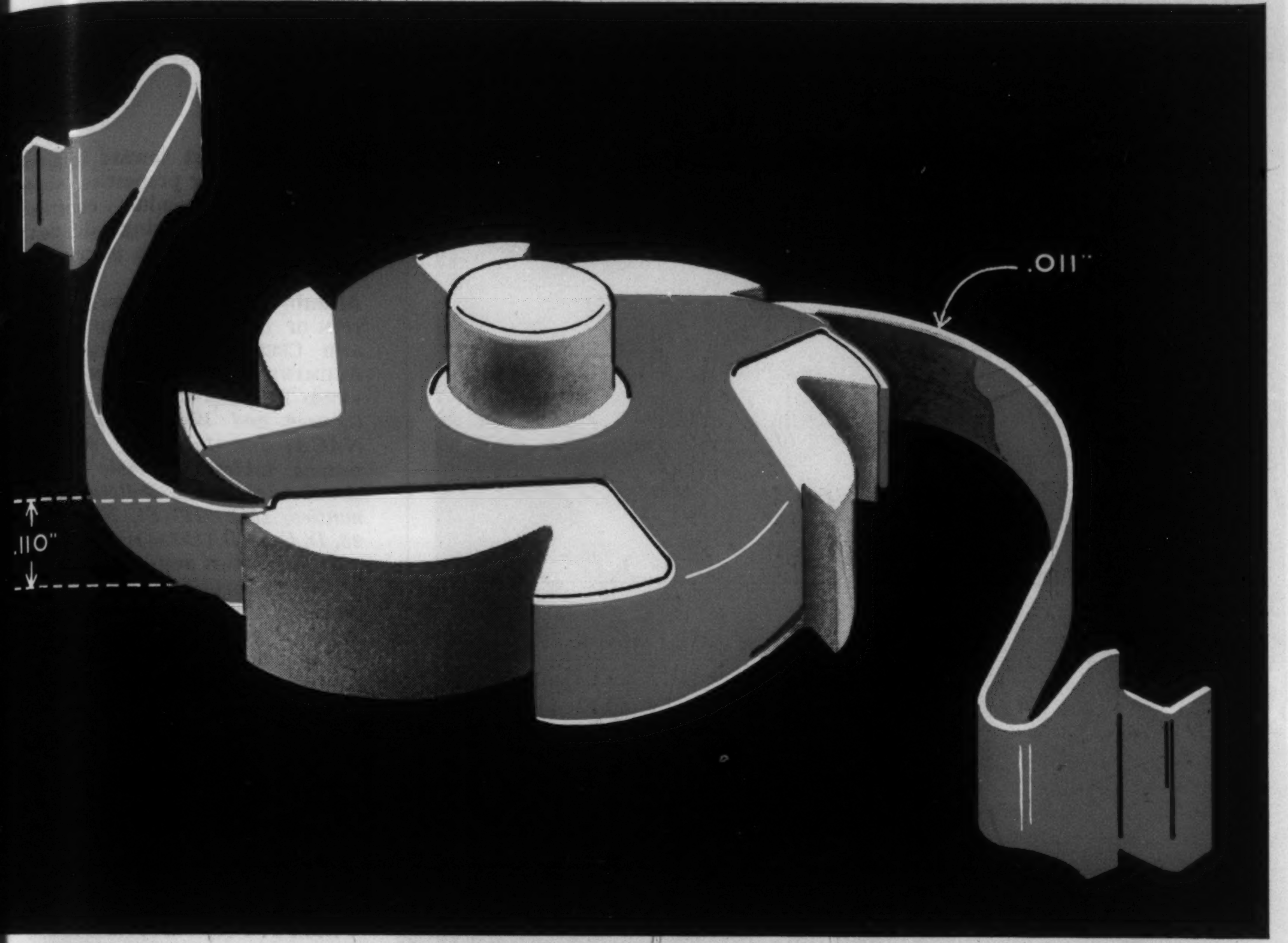
Synthesis of fluorine-containing polymers of the polyether type for evaluation as sealants, rubbers, coatings and adhesives. Desired properties are thermal stability up to 500 F, fuel and oil resistance up to 400 F, retention of properties at −65 F, and resistance to fuming nitric acid and ozone.

Heat resistant paints Development of Heat Resistant Paints. *Murray Kornbluth, Engineer Research and Development Laboratories. Feb 1955. 153 pp, photos, graph, tables. Available from Office of Technical Services, Dept. of Commerce. $4.00. (PB 111957)*

Development of a lusterless, olive drab, corrosion resistant paint for steel surfaces, capable of withstanding temperatures up to 1400 F without film deterioration or loss of protective properties.

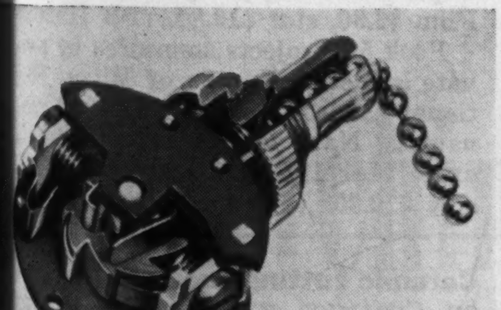
Brazing alloys Development of Brazing Alloys for Joining Heat Resistant Alloys. *Forbes M. Miller, Homer S. Gonser and Robert L. Peaslee, Wall Colmonoy Corp. July 1955. 73 pp, diags, graphs, tables. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. $2.00. (PB 121001)*

Alloys studied were nickel base binary and ternary systems containing such metals and metalloids as phosphorus, silicon, chromium, manganese, molybdenum, tungsten and iron. Phosphorus and manganese



Enlargement showing the contact springs at the "heart" of one model of the Levolier® switch mechanism. Levolier switches are used in industrial and commercial lighting, in heavy-duty industrial sockets, in appliances, fixtures, etc.

he Anaconda alloy tailored for this unishing service actually costs less



utaway of Levolier Switch No. 41 shown pproximately actual size.

HE PROBLEM: The McGill Manufac- ring Company, Inc., Valparaiso, In- ana, was interested in a desirable sub- itute for a premium copper alloy used contact springs for their widely known evolier switch mechanisms. Unexcelled uality had to be maintained with a new loy that would help hold prices against sing costs. As these switches are de- gned for long service and heavy-duty industrial service, the spring material has to be tough and durable.

THE SOLUTION: In 1952, McGill discussed the problem of an alternate spring material with a metallurgical engineer from The American Brass Company. After an analysis of the requirements, a special Anaconda alloy was offered—Ambronze-422, rolled to spring temper.

Samples were prepared and tested by McGill and Underwriters' Laboratories. The material performed satisfactorily in standard tests—current carrying capacity, 6 amps at 125 volts d.c.—readily exceeded the requirements of 75,000 cycles, or 150,000 individual operations.

In production, the new Anaconda alloy also performed satisfactorily. It was necessary to make only one minor die-forming change. McGill received a desirable saving in material costs—product quality remained high—and the material was available as needed to maintain production.

FREE TECHNICAL SERVICE: This is another example of the Anaconda technical service available to metal users. Sometimes a new alloy is required—other times a variation of a standard alloy will do the job. The Technical Department of The American Brass Company, through its day-to-day work with a wide variety of metal problems, offers a tremendous breadth of experience, which is at your disposal. See your American Brass Company representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5664

ANACONDA® COPPER AND COPPER ALLOYS

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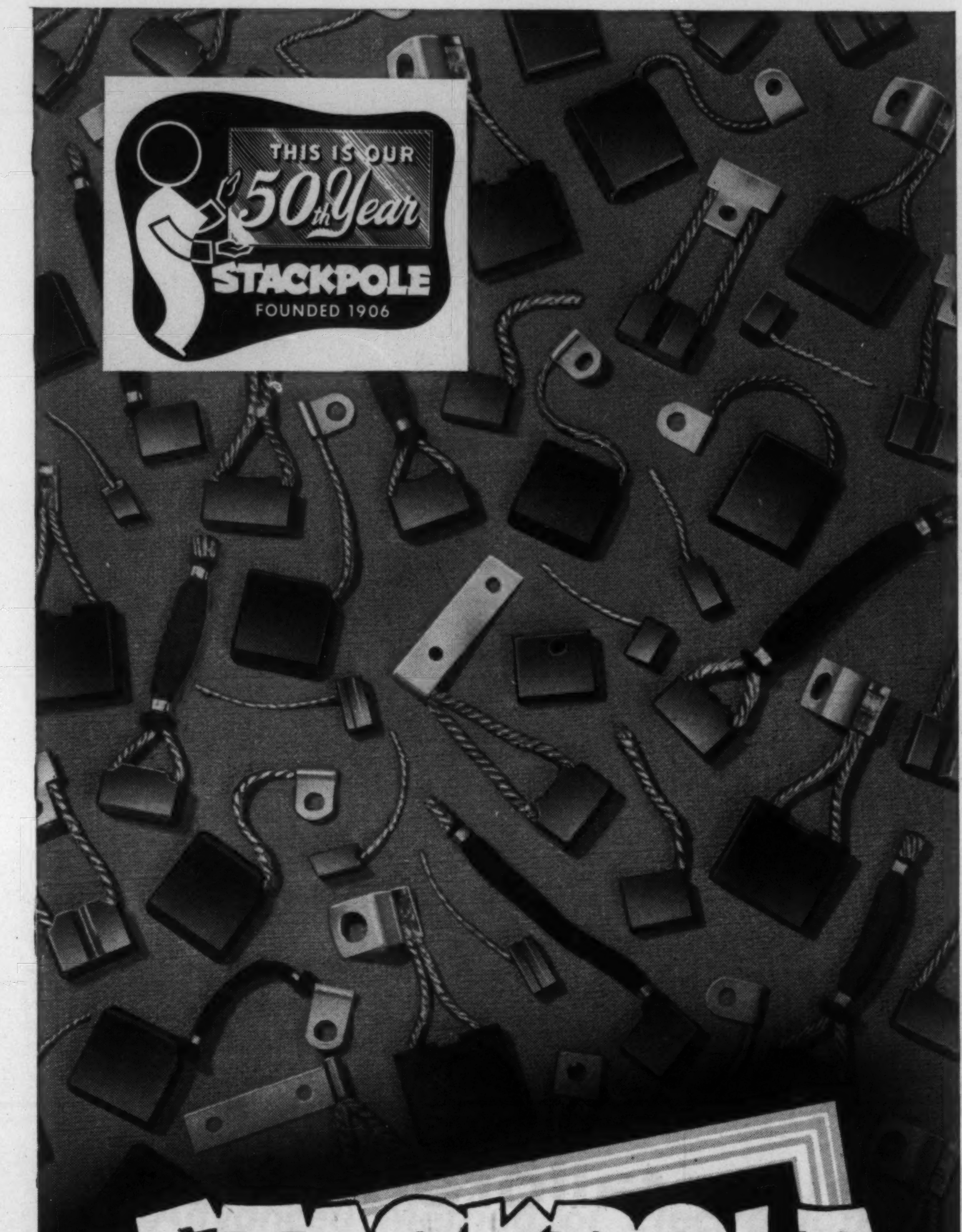

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contributed most toward improving flow and wetting properties, whereas silicon and chromium contributed most toward improving oxidation resistance and strength properties.

Aluminum alloy plates INVESTIGATION OF THE COMPRESSIVE STRENGTH AND CREEP LIFETIME OF 2024-T3 ALUMINUM-ALLOY PLATES AT ELEVATED TEMPERATURES. *Eldon E. Mathauser and William D. Deveikis, NACA, Jan 1956. 40 pp, photos, graphs, tables. Available from National Advisory Committee for Aeronautics, 1512 "H" St. N.W., Wash. 25, D. C. (PB 119388)*

Strength test results indicate that a relation previously developed for predicting plate compressive strength at room temperature is satisfactory for determining elevated temperature strength. A convenient time-temperature parameter is used to develop master creep-lifetime curves.

Titanium programs TITANIUM AND TITANIUM ALLOYS PROGRAM. *Air Materiel Command. Available from Library of Congress, Photoduplication Service, Publications Board Project, Wash. 25, D. C.*

Book 1: Projects sponsored by Air Materiel Command. Mar 1955. 43 pp. Film $3.30, stat $7.80. (PB 119261)

Book 2: Projects sponsored by Air Research and Development Command (WADC) Mar 1955. 98 pp. Film $5.40, stat $15.30. (PB 119262)

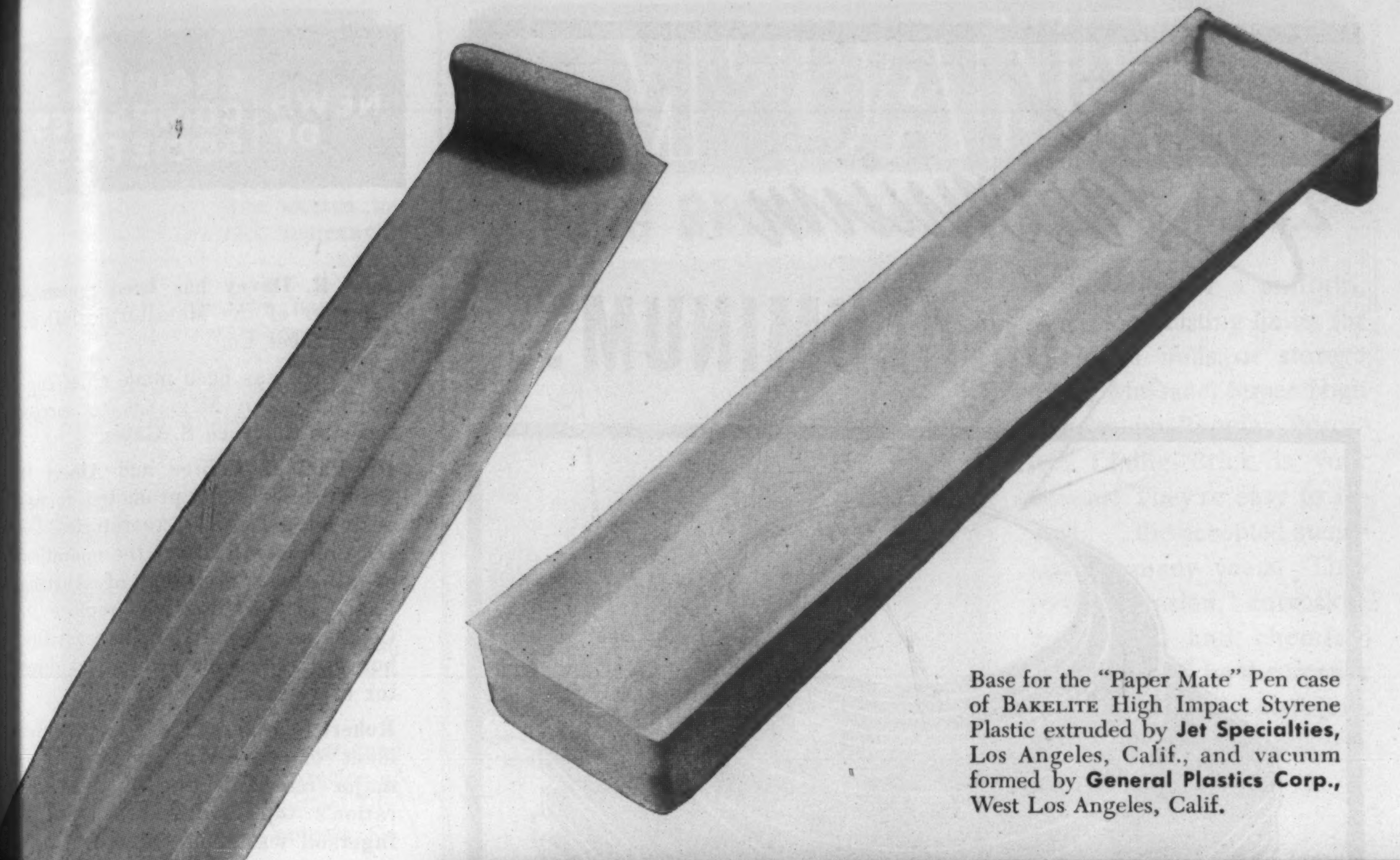
Book 3: Projects sponsored by Dept. of the Navy. Mar 1955. 81 pp. Film $4.80, stat $13.80. (PB 119264)

Book 4: Projects sponsored by Dept. of the Army. Mar 1955. 130 pp. Film $6.30, stat $19.80. (PB 119265)

Book 5: Projects sponsored by private industry, Bureau of Mines, National Advisory Committee for Aeronautics, National Bureau of Standards. Mar 1955. 77 pp. Film $4.50, stat $12.30. (PB 119263)

Ceramic cutting tools UTILIZATION OF CERAMICS FOR METAL CUTTING TOOLS. *W. B. Kennedy, Watertown Arsenal. Dec 1954. 31 pp, photos, diags, tables. Available from Office of Technical Services, Dept. of Commerce, Wash. 25, D. C. $1. (PB 111758)*

Fourteen types of ceramics were investigated. Initial studies were based on finishing and roughing bar stock operations. Workpiece materials included FS-1020 and FS-4140 annealed steel, half-hard commercial brass and low alloy cast iron. All results based on linear travel passes utilizing a standard 18-in. engine lathe.



Base for the "Paper Mate" Pen case of Bakelite High Impact Styrene Plastic extruded by **Jet Specialties,** Los Angeles, Calif., and vacuum formed by **General Plastics Corp.,** West Los Angeles, Calif.

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Eye-catching display package

There are three important advantages for the Paper Mate Pen Company in this attractive container with base fabricated from Impact Styrene. It's an eye-appealing display that stimulates impulse buying. It's a sturdy package that keeps the pen fresh-looking and salable. And, the base is produced fast and at low cost by vacuum forming from high gloss flat extruded sheets of Bakelite Impact Styrene, without costly finishing operations.

Your package, product or display may call for this plastic or one of many others; vinyls, phenolics, polyethylenes, styrenes, polyesters or epoxies. The best way to decide is to come to Bakelite Company where you find the greatest variety and the largest resources keyed to your needs. Write Dept. QR-108.

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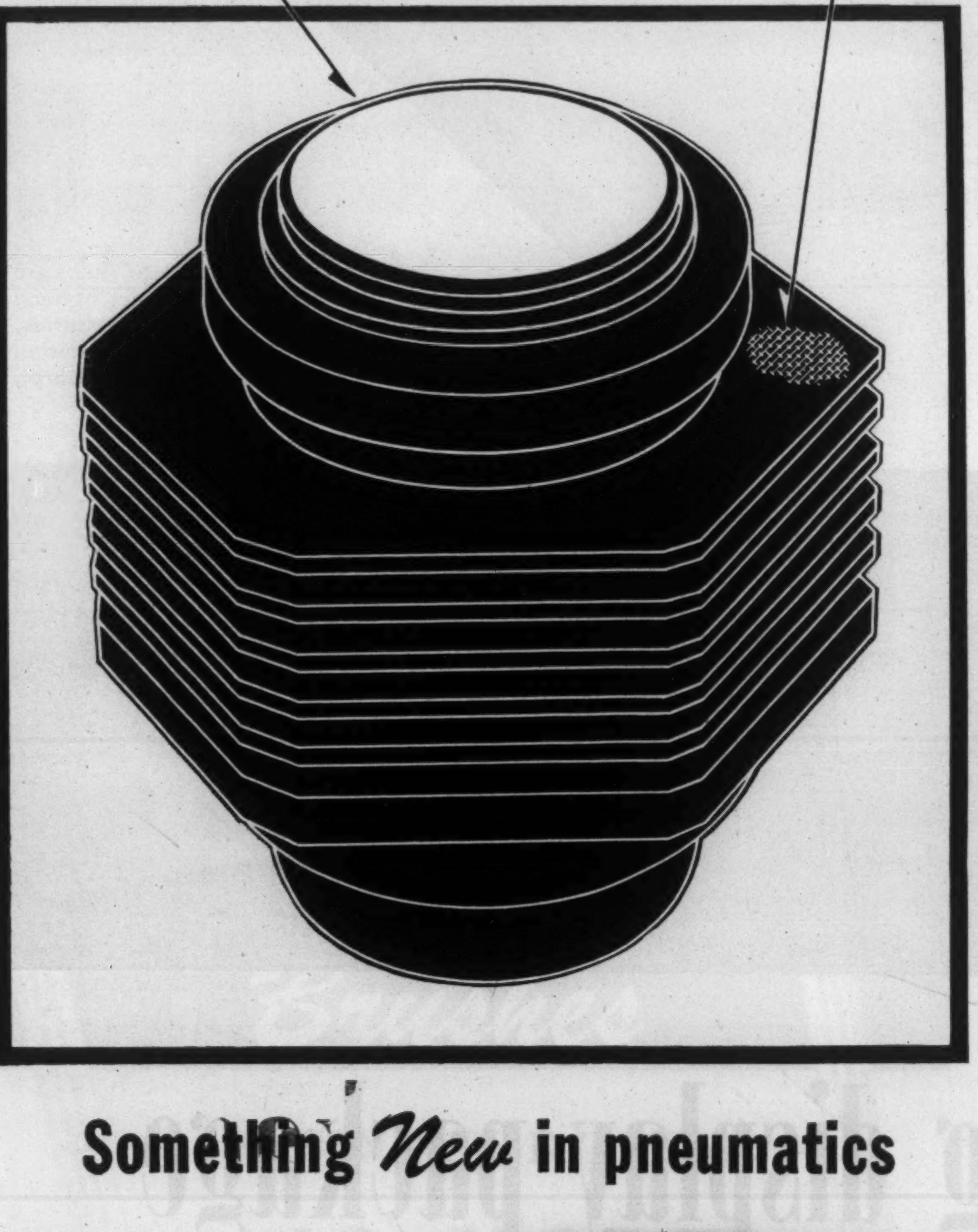
Chromium ON ALUMINUM..



Something New in pneumatics

by VAN DER HORST
TRADE MARK

Write for additional information on this specialized application for Chromium.

Dept. L, VAN DER HORST CORP., OLEAN, N. Y.

NEWS OF ENGINEERS COMPANIES SOCIETIES

John R. Davey has been appointed manager of the Metallurgical Dept., Acme Steel Co.

Paul Pick has been made chief engineer of Allen Mfg. Co. to succeed the late Clarence S. Gates.

Dr. Paul F. Collins and **Albert M. Talbot** have been promoted to new posts at Austenal Laboratories, Inc. Dr. Collins will direct the operations of all three divisions of Austenal Labs. Mr. Talbot will replace Dr. Collins as head of the Microcast Div., but will retain his position as director of research.

Robert S. Ingersoll was elected president of Borg-Warner Corp. in a major reorganization of the corporation's top management. **Roy C. Ingersoll** was reelected board chairman and was named chief executive officer, but relinquished the presidency which he has held for six years. **Lester G. Porter** was elected to the newly recreated position of executive vice president.

Dr. Richard D. Burlingame was presented the 1956 Journal of Metals Award by the American Institute of Metallurgical Engineers.

G. W. Trichel, formerly executive vice president and general manager of the Amplex Div. of Chrysler Corp., is now president of the division. Mr. Trichel succeeds **A. J. Langhammer** who has retired.

Al Gross is chief engineer of Cleveland Metal Specialties Co.

Robert R. Freeman is now manager—arc-cast molybdenum development for Climax Molybdenum Co. Prior to joining Climax, Mr. Freeman had been associated with Westinghouse Electric Corp. in various engineering and supervisory capacities.

Samuel A. Ott has joined Colorado Fuel and Iron Corp. as works manager of the corporation's Claymont, Del., plant.

Dr. Stuart D. Brewer has been appointed manager — resin product engineering, **Dr. Frederick M. Lewis**, manager—advance development, **Dr. Abbott Pozefsky,** manager—analytical and control methods unit, and **Dr. William F. Gilliam,** specialist—technical information exchange, Silicone Products Dept., General Electric Co.

(more News on p 201)

news of | ENGINEERS

r. George A. Roberts, vice presi- ent of technology, Vanadium-Al- oys Steel Co., has been elected to ll a vacancy on the company's oard of directors.

r. Carl Frederick Floe has been lected a director of Walworth Co. r. Floe is professor of metallurgy nd assistant provost at Massachu- etts Institute of Technology.

r. Robert K. Smith, formerly asso- iated with Houdry Process Corp., is anager of research for E. F. oughton & Co.

r. Irving Roberts, who has been ssociated with Reynolds Metals Co. s a consulting engineer, has been ppointed director of planning for he company.

ernon H. Vogel has been assigned he newly created post of director of ngineering for the Aeronautical Div. f Robertshaw-Fulton Controls Co.

r. Bennett S. Ellefson has been lected vice president—engineering nd research, and **Marion E. Pette- rew,** vice president—tungsten-chemical and parts operations, Sylvania Electric Products, Inc.

Howard J. Bowman has been made director of research and development for Trent Tube Co.

Clayton A. O'Neill has been added to the staff of Wellman Bronze & Aluminum Co. as manager of the Permanent Mold Div. Mr. O'Neill most recently held the position of superintendent of the Light Metals Div., Thompson Products, Inc.

E. C. Schmachtenberg, formerly assistant to the manager of engineering and chief engineer, compressors, is now assistant to the manager of engineering, Harrison Div., Worthington Corp. Other promotions in the same division include: **Hunt Davis** formerly chief engineer, compressor development, now chief engineer, compressors; **C. A. Macaluso,** previously assistant manager, research and development, now assistant chief engineer, compressors; **W. F. Donovan,** formerly group supervisor, research and development, now assistant manager, research and development.

Robert W. Buzzard, a project leader in the Metallurgy Div., National Bureau of Standards, died suddenly on May 3.

(News of Companies on p 202)

For more information, turn to Reader Service Card, Circle No. 374

McDANEL

LINING BRICK FOR TANKS & MILLS

Note the clean, smooth fit with McDanel Lining Brick. 1½", 2" and 2½" thickness—tapered for 15" to 96" diameters.

- Looking for a uniform, clean, long lasting lining for your ball mills or storage tanks? McDanel Super High Density or Regular Porcelain Lining Brick is your answer! They're easy to install . . . the accepted standard for many years. They resist abrasion, corrosion, heat, cold and chemical action. Could be the answer to your lining problem. Better contact us today!

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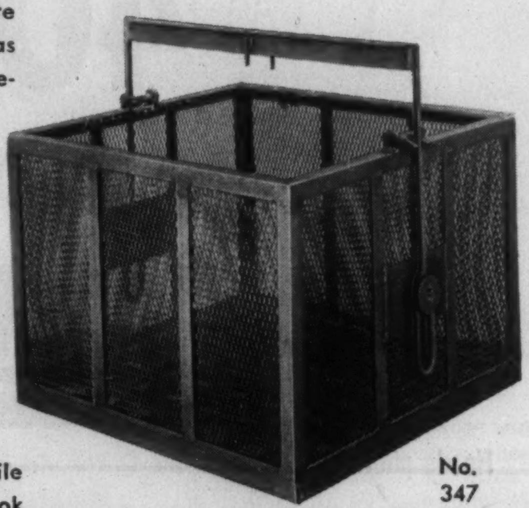
This side dumping, low temperature heat treating and quenching basket was designed to meet the specific requirements of one of our customers—and that it does. Heat resistant alloy throughout, amply reinforced bottom, easy to load, dump and handle through the furnace.



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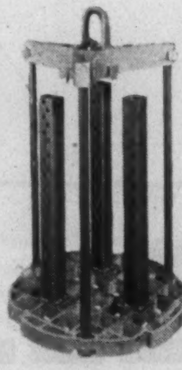

No. 313

This durable, versatile carburizing fixture took care of another customer. Handles spiders, ring gears, collars, bushings, etc., which are slipped over the square perforated tubes. Stanwood Heat Treating Equipment can solve your problem—Send for Catalog.

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For more information, turn to Reader Service Card, Circle No. 529

news of | COMPANIES

Carborundum Co. will increase its capacity for production of zirconium to over 1½ million lb per year with the construction of a new plant in Parkersburg, W. Va. The new plant will be operated by a subsidiary, Carborundum Metals Co., Inc.

Electric Storage Battery Co. has formed a new Alkaline Div. in the Engineering Dept. of Exide Industrial Div. in order to consolidate alkaline battery programs.

New York University College of Engineering has opened a new mechanical engineering design and research laboratory located on the University Heights campus.

Newman-Crosby Steel Co. has completed the installation of new rolling and annealing facilities which have raised the plant's capacity by 40%.

Nortmann-Duffke Co. has changed its name to **McKey Perforating Co., Inc.**

Reynolds Metals Co. has completed plans for a new aluminum foil plant at Torrance, Calif. Some phases of production in the plant are expected to be in operation by the end of this year.

Trimedge, Inc., has announced reorganization of the firm under the name **Empire Aluminum Co.** Plans are currently under way for a substantial building expansion program with the end objective of tripling the firm's present productive capacity.

U. S. Industrial Chemicals Co., Div. of National Distillers Products Corp., has revealed plans to complete a 500,000-lb-per-year semicommercial metals plant to be located near its contemplated zirconium sponge plant in Ashtabula, Ohio.

Canadian Titanium Pigments Ltd., a subsidiary of National Lead Co., has begun construction of a titanium pigment plant at Varennes, Quebec.

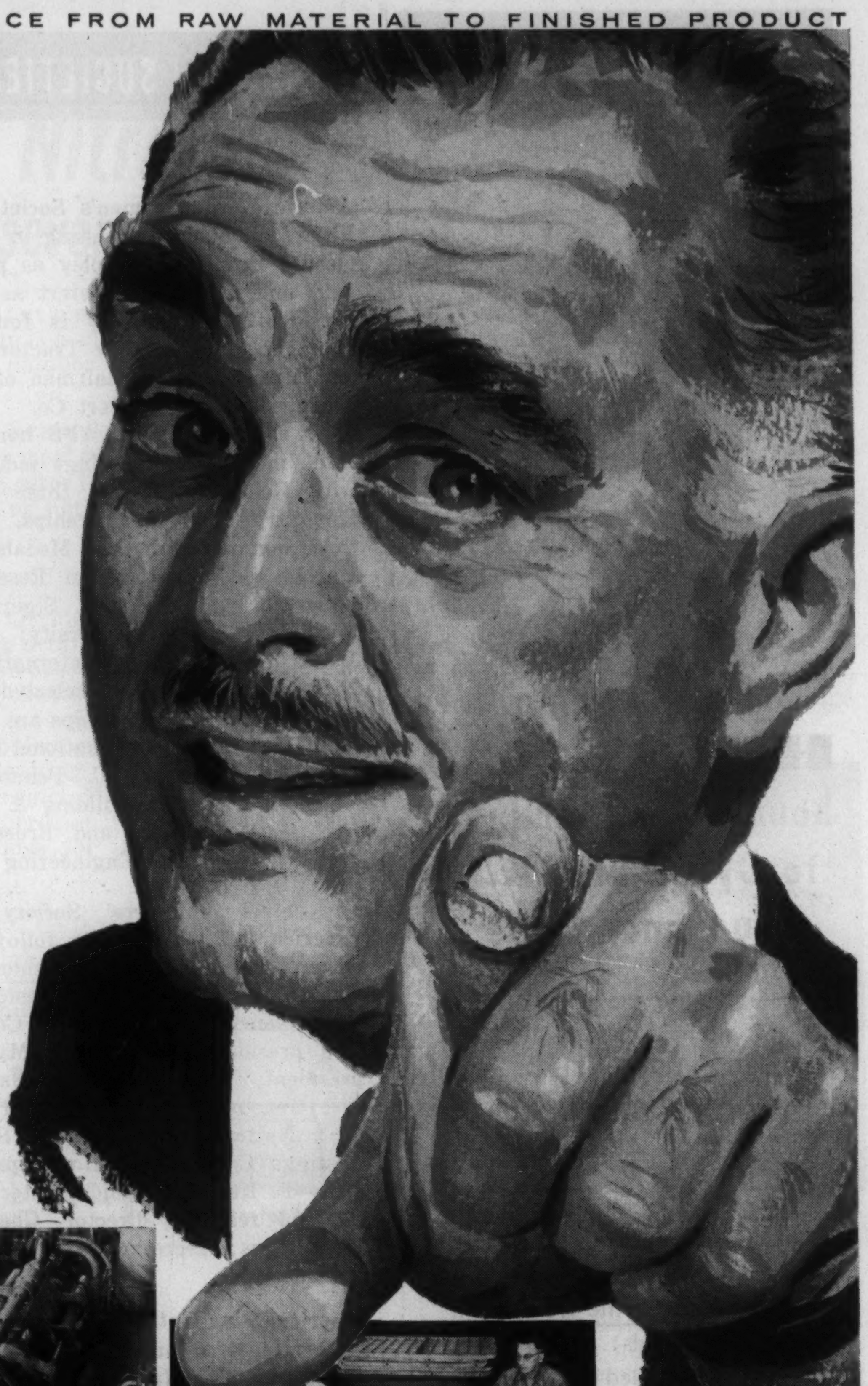
National Lead Co. has announced an expansion program which will increase the capacity of the die casting facilities of the Doehler-Jarvis Div. by 20 million lb of aluminum and 15 million lb of zinc per year.

Stainless Welded Products, Inc., has announced the opening of its new plant and offices located at One Clifton Blvd., Clifton, N. J.

(News of Societies on p 204)

AMPCO — ONE-SOURCE SERVICE FROM RAW MATERIAL TO FINISHED PRODUCT

You're the *boss* when you design with Ampco Alloys



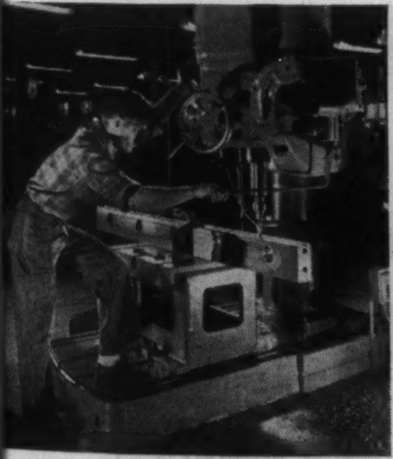
You're not limited to a single copper-base alloy or a single form

Your design behaves the way you want it to, after it takes shape in one of more than 100 Ampco alloys.

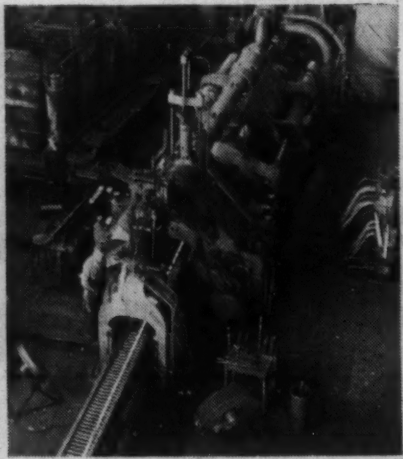
Why? Because whether you are looking for resistance to wear, impact, fatigue, or corrosion, Ampco has a tailor-made alloy to meet your requirements.

And besides, you have flexibility in selecting the most economical form of production. Why? Because Ampco is available in sand-cast, centrifugally-cast, shell-molded, precision-cast, fabricated, forged, extruded, and sheet and plate forms. A call to your nearby Ampco field engineer will get you an unbiased recommendation.

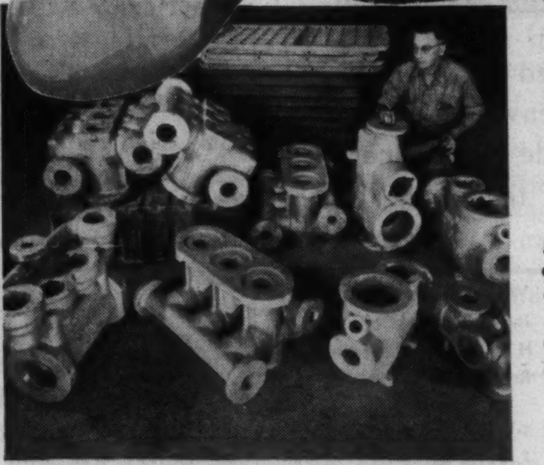
Write for Bulletin 33 describing the Ampco Metal series of alloys.



Ampco's one-source service includes production-run machining of Ampco copper-base alloys to the quality standards of the aircraft industry.



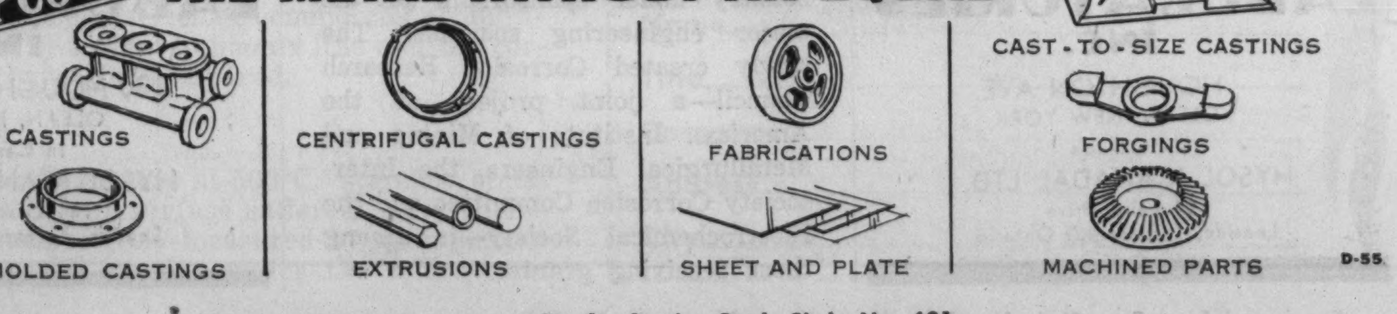
2,275-ton hydraulic press in Ampco's modern, laboratory-controlled mill for extruding rods, bars, hollow rounds, and shapes.



Meter housings and fluid ends. Ampco produces sand castings like these up to 14,000 pounds — and centrifugal castings up to five tons.

AMPCO METAL, INC. Dept. MA-7, Milwaukee 46, Wisconsin • West Coast Plant: Burbank, California

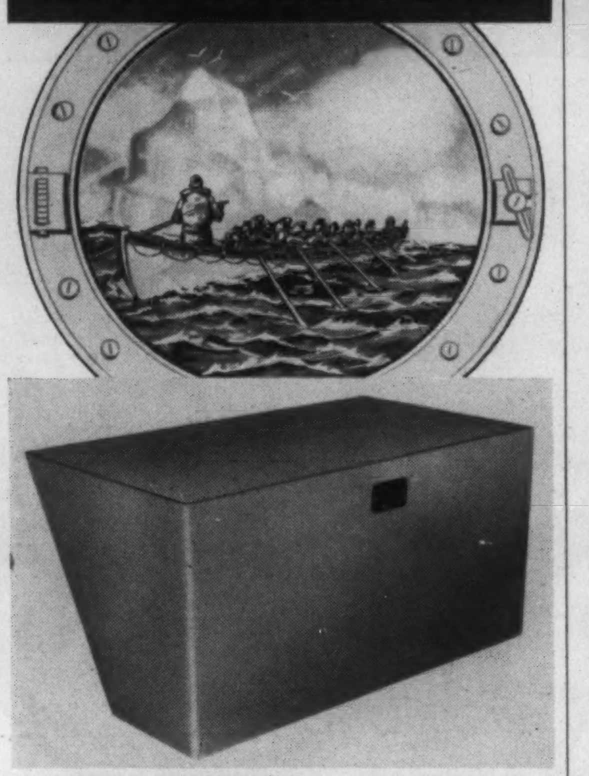
AMPCO® THE METAL WITHOUT AN EQUAL



D-55

For more information, turn to Reader Service Card, Circle No. 481

Another HYSOL Use



HYSOL 2020
bonds glass laminate
to Dylite in Welin
Buoyancy Units

To manufacture the compact, light weight lifeboat buoyancy unit, Welin Davit and Boat Division, Continental Copper & Steel Industries, Inc. use HYSOL 2020 with excellent results.

To meet the requirements of Military specifications, this unit made of polyster glass encasement is filled with Dylite (expanded polystyrene beads). The cover must then be bonded with HYSOL 2020 both to the envelope and to the Dylite to provide an absolutely pressure and water tight seal.

PROGRESSIVE PRODUCTS HYSOL Product of HOUGHTON LABORATORIES, INC. THRU CHEMICAL RESEARCH

Whatever your bonding problems, check HYSOL adhesives first.

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In Canada
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184 Laird Drive
Leaside, Toronto 17, Ontario

For more information, Circle No. 466

news of | SOCIETIES

American Foundrymen's Society, at its annual business meeting in May, elected Frank W. Shipley as president and Harry W. Dietert as vice president. Mr. Shipley is foundry manager of Caterpillar Tractor Co., and Mr. Dietert is chairman of the board, Harry W. Dietert Co.

At the same time, AFS honored three men of the castings industry with Gold Medals and three with Honorary Life Memberships. The three honored with Gold Medals are Harold F. Bishop, Naval Research Laboratories; Charles C. Sigerfoos, Michigan State University; and James S. Vanick, International Nickel Co. The three selected for Honorary Life Memberships are William D. McMillan, International Harvester Co.; Joseph C. Pendleton, Newport News Shipbuilding & Dry Dock Co. (retired); and Bruce L. Simpson, National Engineering Co.

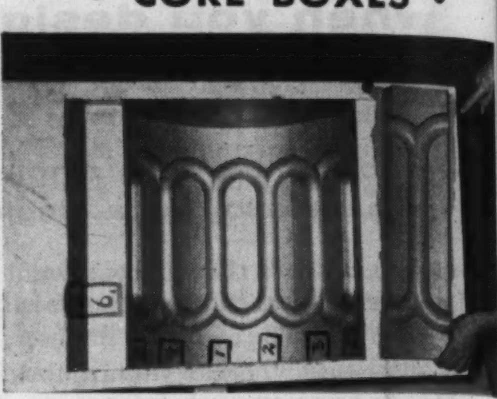
The Steel Founders' Society of America has elected the following officers for 1956-1957: president—Howard F. Park, Jr., vice president, sales, General Steel Castings Corp.; vice president—George W. Myers, president, Crucible Steel Casting Co.; treasurer—R. G. Parks, treasurer, National Malleable and Steel Castings Co.; executive vice president—F. Kermit Donaldson; technical and research director—Charles W. Briggs; secretary—George K. Dreher.

American Zinc Institute has reelected F. S. Mulock as president for a second term. Mr. Mulock is president of U. S. Smelting Refining & Mining Co. Also reelected for a second term are three vice presidents: C. Merrill Chapin, Jr., St. Joseph Lead Co.; R. G. Kenly, New Jersey Zinc Co.; and E. H. Snyder, Combined Metals Reduction Co.

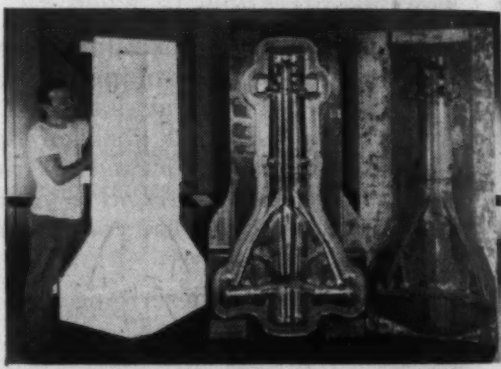
Engineering Foundation has appropriated new grants totaling $53,000 for the 1956-57 fiscal year. They will go to 27 projects being carried out mainly in university, government and industrial laboratories all over the country under sponsorship of the major engineering societies. The newly created Corrosion Research Council—a joint project of the American Institute of Mining and Metallurgical Engineers, the Intersociety Corrosion Committee and the Electrochemical Society—is among those receiving grants.

HYSOL
Plastic Tooling
Materials . . .
• Cut Costs
• Save Time
in these applications

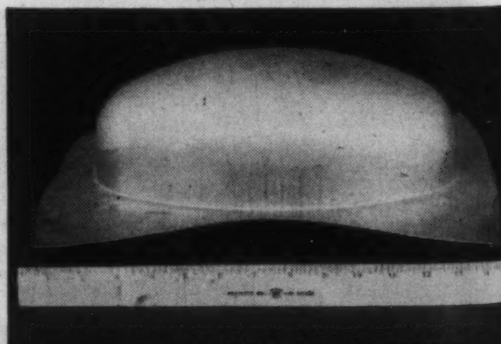
• CORE BOXES •



• KELLER PATTERNS •



• DIE FORMED PART •



PROGRESSIVE PRODUCTS HYSOL Product of HOUGHTON LABORATORIES, INC. THRU CHEMICAL RESEARCH

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Leaside, Toronto 17, Ontario

For more information, Circle No. 459

Inco high temperature research note:

Nitriding

...and its effects on several heat-resisting alloys

As a constituent of many hot atmospheres that employ air for combustion, nitrogen in molecular form is usually considered substantially inert to a large number of metals and alloys.

However, in atomic state—for example, as a transient dissociation product of ammonia — nitrogen may react with surfaces of certain metals and distinctly alter their properties. Whether this may be desirable or not, depends on extent and nature of the reaction.

The Problems

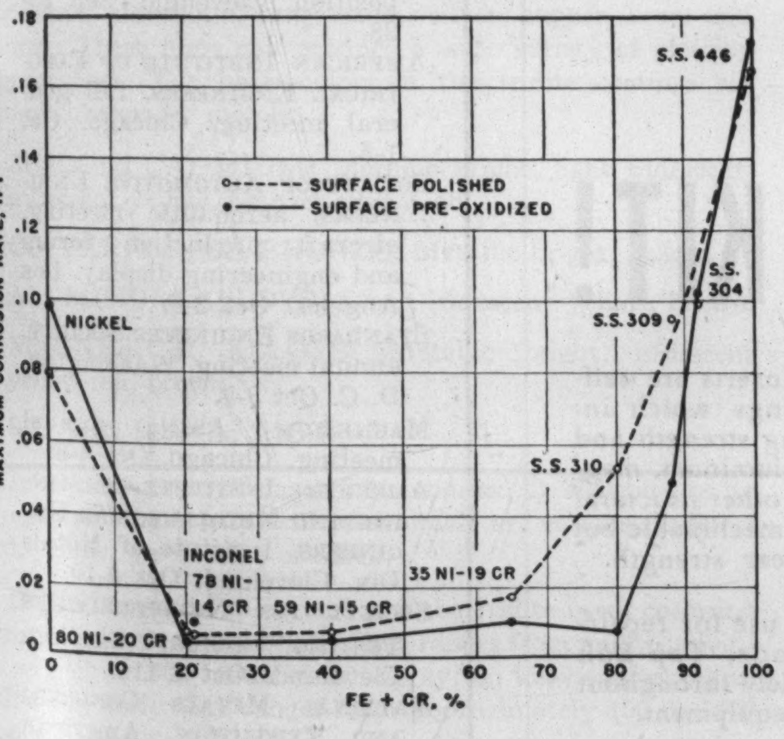
Industry heats steels to be intentionally nitrided, in a freshly dissociated ammonia atmosphere to attain the surface hardening that accompanies formation of nitride phases. But the problem is, to avoid nitriding the furnace chamber, dissociator and other accessories . . . a costly and useless consumption of gas. Another problem exists in chemical plants, where equipment handling hot ammonia must resist the absorption of nitrogen. Here nitriding is a form of high temperature corrosion requiring selection of the most resistant alloys for its prevention.

A Postulate

Field experience had shown that alloys high in nickel resist corrosion and embrittlement by nitrogenous atmospheres. However, to evaluate lower nickel alloys in this type of service, a series of commercial compositions was exposed in a plant ammonia line and the corrosion behavior thereafter compared.

CORROSION OF NI-CR-FE ALLOYS BY ANHYDROUS AMMONIA AT 500°C

BASED ON 1540 HOURS EXPOSURE

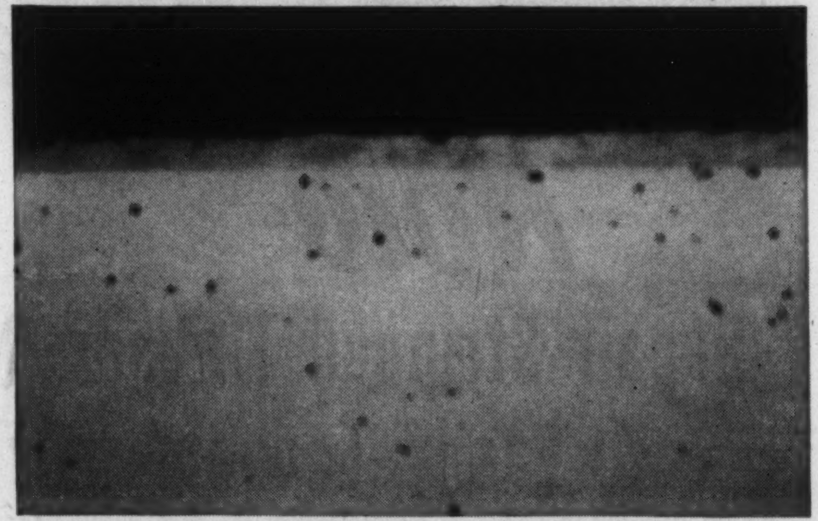


Examination

After 1540 hours' exposure at 500°C, stainless steels having initially a bright surface suffered heavy corrosion that was quantitatively measured by examination of the specimen cross section under the microscope. These measurements were calculated in terms of "inches penetration per year" and the variation in extent of attack with alloy composition is shown in the graph.

When the nickel content is high, as in 80 Ni/20 Cr, 78 Ni/14 Cr (Inconel* nickel-chromium alloy), or 59 Ni/15 Cr, the nitride phases which form are dense and adherent and the corrosion resistance is correspondingly good. Alloys that contain more iron develop porous surface layers and the rate of attack is high. Significantly, apparently some chromium is required to provide corrosion resistance, since under these conditions of exposure, pure nickel is inferior.

An interesting observation from this test is that the stainless steels which were initially heat-treated to form an oxide film were more resistant than specimens with a bright surface.



Material Magnification dark zone nitride rich corrosion layer.

Result of Investigation

Quantitative data obtained from this test in general support past experience that the high nickel compositions are inherently suited for service under nitriding conditions.

Inco has investigated hundreds of metals and alloys under high temperature operating conditions. If you have a metal problem involving high temperature performance in corrosive media, let us help you. Send for our High Temperature Work Sheet . . . a form that makes it easy for you to outline your problem to us. Use the coupon now.

*Registered Trademark

The International Nickel Company, Inc.
67 Wall Street, New York 5, N. Y.

Please send me the High Temperature Work Sheet so that I may outline my problem to you.

Name____________________

Title____________________

Company____________________

Address____________________

City____________________ **State**__________

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Repair stripped threads this quick easy way
1. Drill Hole
2. Drive Insert
TAP-LOK®
Self-Tapping INSERTS (PATENTED)
FOR Quick THREAD REPAIR
Manufactured by
GROOV-PIN CORPORATION
Hendricks Causeway, Ridgefield, N.J.

Now

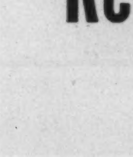
Repair Stripped Threads Quickly, Easily, Economically with the NEW

TAP-LOK® REPAIR KIT!

For the first time, Tap-Lok Inserts are available in a Repair Kit...to provide you with the easiest, most practical method of repairing worn or damaged threads. Just two steps are necessary . . . drill the hole, drive the insert. The kit includes all that is needed to do the job . . . a driving tool, Tap-Lok Inserts in the size you specify, easy-to-follow, illustrated instructions.

Low-cost Tap-Lok Inserts are self-tapping steel bushings which increase thread-holding strength and wear resistance in aluminum, magnesium, plastics, and other structural materials which are machinable but have inadequate shear strength.

In addition to their use for repairing stripped threads, Tap-Lok Inserts are used widely throughout industry as original equipment.



Write for further details on prices, thread sizes available, etc.

Also manufacturers of Groov-Pins for positive locking press fit.

GROOV-PIN CORPORATION

1123 Hendricks Causeway Ridgefield, New Jersey

For more information, turn to Reader Service Card, Circle No. 439

Meetings and Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, West Coast meeting. San Francisco. Aug 6-8.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting, Denver. Sep 10-12.

SOCIETY OF AUTOMOTIVE ENGINEERS, tractor meeting and production forum. Milwaukee. Sep 10-13.

AMERICAN DIE CASTING INSTITUTE, annual meeting. Chicago. Sep 11-13.

AMERICAN SOCIETY FOR TESTING MATERIALS, Pacific Coast meeting. Los Angeles. Sep 16-22.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Instruments and Regulators Div., and Instrument Society of America, exhibit and joint conference. New York. Sep 17-21.

PORCELAIN ENAMEL INSTITUTE, annual meeting. Colorado Springs, Colo. Sep 19-21.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, petroleum-mechanical engineering conference. Dallas, Tex. Sep 23-26.

STEEL FOUNDERS' SOCIETY OF AMERICA, fall meeting. White Sulphur Springs, W. Va. Sep 24-25.

ATOMIC INDUSTRIAL FORUM, trade fair. Chicago. Sep 24-28.

ASSN. OF IRON AND STEEL ENGINEERS, iron and steel exposition. Cleveland. Sep 25-28.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, fall general meeting. Chicago. Oct 1-5.

SOCIETY OF AUTOMOTIVE ENGINEERS, aeronautic meeting, aircraft production forum and engineering display. Los Angeles. Oct 2-6.

STANDARDS ENGINEERS SOCIETY, annual meeting. Washington, D. C. Oct 3-5.

MAGNESIUM ASSN., annual meeting. Chicago. Oct 4-5.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, Institute of Metals Div. Cleveland. Oct 8-10.

SOCIETY FOR NONDESTRUCTIVE TESTING, annual meeting. Cleveland. Oct 8-11.

NATIONAL METALS CONGRESS AND EXPOSITION, American Society for Metals. Cleveland. Oct 8-12.

AMERICAN WELDING SOCIETY, national fall technical meeting. Cleveland. Oct 8-12.

SOCIETY OF THE PLASTICS INDUSTRY, New England Section conference. Portsmouth, N. H. Oct 11-12.

SPECIAL REPORTS ON FINISHING NON-FERROUS METALS

NUMBER I—Decorative, Corrosion-Resistant Finishing with Iridite

WHAT IS IRIDITE®?

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002" max.) gel-like, complex chromate film of a non-porous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

Chromate conversion coatings are well known and accepted throughout industry as an economical means of providing corrosion protection, a decorative finish or a good paint base for non-ferrous metals. However, continued developments are so rapid and widespread that many manufacturers may not be completely aware of the breadth of application of this type of finish. Hence, this digest of current information; to bring you up to date on the many ways in which you can combine salable appearance with durability in one finish at a competitive price advantage. Report II on paint base, corrosion-resistant finishes and Report III on chemically polished, corrosion-resistant finishes are available on request.

First, as a basis for this discussion, a "decoratiye" finish is considered as any chromate film that is used as a final finish in itself. It may be truly decorative in that its sole purpose is to enhance the beauty of the product. For example, a bright chrome-like finish or a pleasing bronze appearance are among the many effects that can be obtained. It may be functionally decorative in that it reduces reflectivity for camouflage purposes or provides a means of color-coding parts. But, in all cases, the Iridite films protect the metal against corrosive attack.

Iridite finishes are now available for all commercial forms of the more commonly used non-ferrous metals, including zinc, cadmium, aluminum, magnesium, silver, copper, brass and bronze. These films can produce a wide variety of pleasing appearances. The basic colors of the Iridite coatings are grouped below by metals.

ZINC and CADMIUM: Metallic bright, light iridescent, iridescent yellow, bronze, olive drab.

COPPER, BRASS, BRONZE: Metallic bright, yellow.

ALUMINUM ALLOYS: Clear, iridescent yellow, brown.

MAGNESIUM ALLOYS: Metallic bright, iridescent yellow-red, brown.

SILVER: Metallic bright.

In addition, many films can be modified by bleaching or by dyeing. Among the dye colors available are various shades of red, yellow, green, blue or black.

Depending upon the metal and the Iridite used, corrosion resistance of clear and bright films ranges from mild passivity to as high as 500 hours in salt-spray; on heavier dark films, salt-spray resistance ranges from approximately 100 to 1000 hours.

It is this combination of decorative and corrosion resistant properties that accounts for the widening use of Iridite finishes. For example, Iridites #4-73 and #4-75 (Cast-Zinc-Brite) make possible for the first time, a combination of lustrous chemical polishing of the as-cast surface of zinc die castings and good resistance to corrosion. Further, in many cases, sizeable savings in the cost of buffing and electroplating are realized.

On many steel parts, a simple system of zinc or cadmium plate and bright Iridite is used instead of more costly electroplated finishes to provide a bright, decorative and protective finish with tremendous savings in material, equipment and labor.

In finishing aluminum, where corrosion resistance or paint adherence is the prime consideration, the aircraft industry has all but abandoned the anodizing process in favor of recently developed chromate conversion coatings, among them Iridite #14 and #14-2 (Al-Coat). These formulations and their method of application can be varied to retain the original metallic appearance while providing acceptable corrosion resistance, or to produce a fully colored brown finish that offers exceptional corrosion protection. Again, time and manpower savings are astounding—one company saved at least $15,000 a year on maintenance of racks alone and another $40,000 on materials and labor in only nine months. In addition, of course, hundreds of thousands of dollars are saved by eliminating the need for expenditures for generators, heating equipment and racks.

Iridites are widely approved under both Armed Services and industrial specifications because of performance, low cost and savings of materials and equipment.

In planning or designing, you should consider the many other characteristics of Iridite finishes which may enter into the specific problem. In addition to having decorative and protective functions, these chromate coatings form an excellent base for organic finishes and bonding compounds. They have low electrical resistance. Some can be soldered and welded. The Iridite film itself does not affect the dimensional stability of close tolerance parts.

You can see then, that with the many factors to be considered, selection of the Iridite best suited to your product requires the services of a specialist. That's why Allied maintains a staff of competent Field Engineers—to help you select the Iridite to make your installation most efficient in improving the quality of your product. You'll find your Allied Field Engineer listed under "Plating Supplies" in your classified telephone book. Or, write direct and tell us your problem. Complete literature and data, as well as sample part processing, is available. Allied Research Products, Inc., 4004-06 E. Monument Street, Baltimore 5, Maryland.

(Adv.)

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Non-Aircraft Engineers

Lockheed will train you for various types of aircraft engineering—at full pay

Mechanical Engineers can become
Thermodynamicists
Stress Analysts
Structures Engineers
Weight Engineers
Research Engineers
Flight Test Engineers
Design Engineers

Civil Engineers can become
Flight Test Engineers
Stress Engineers
Structures Engineers
Research Engineers in Structures
Design Engineers

Electrical Engineers can become
Electronic Research Engineers
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Flight Test Engineers
Design Engineers

What Lockheed offers you:

Promotion Opportunities are excellent because there are so many supervisory positions to be filled with 46 major projects in progress at Lockheed—and because Lockheed is in an expanding development and production program.

Scope for your ability You can show what you can do because Lockheed activities range across virtually the entire spectrum of aeronautical endeavor. You are not limited to one type of work because Lockheed is so diversified in projects. Moreover, Lockheed encourages and welcomes personal initiative.

Salary increase You may receive a substantial increase in pay because Lockheed is extremely liberal in direct salary and in extra employee benefits which actually increase the value of your position by an average of 14%. *Moreover, engineering salaries have just been raised 6%.*

Space prevents us from listing all the reasons why we believe engineers can improve their career at Lockheed. There are many. But if our remarks have made sense to you, write and we can explore your opportunities at Lockheed through personal interview or phone. Resumé form at right is simply for your convenience in contacting us.

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Dear Sir: Please send me your brochure describing life and work at Lockheed in Southern California.

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For more information, turn to Reader Service Card, Circle No. 508

MATERIALS ENGINEERING NEWS

continued from p 13

upon close control of thermal distortion and shrink during the casting process. The epoxy casting is also supported by structural steel to minimize deflection during operation.

Molding process

Flexibility and ease of operation of the new molding process are demonstrated by Sterling's experience in producing bathtubs that resemble porcelain from fiberglass reinforced plastics.

The polished stainless steel surface of the male bathtub mold is coated with pigmented polyester resin to provide the shiny bathtub surface. Because the temperature of this surface can be raised or lowered within a fraction of a minute, the mold coat is sprayed on at a temperature just below that at which styrene is driven off. After a few seconds the mold coat gels and the preform and resin are applied. The mold is closed and the temperature raised to give cures comparable to those obtained with matched steel dies. Since the stainless steel surface temperature is variable up to 350 F, mold coats of several different types of plastics can be applied.

Vacuum applied to the molding cavity during the period of closure is vital to the process. A slight amount of styrene is vaporized and exhausted, as are the water vapor and air dissolved in the resin and absorbed in the surface of the glass fibers. When the part fills out and the resin reaches the cut-off bars, the closing pressure collapses the styrene vapor voids in the resin and a void-free part is produced. Removal of air and water vapor also increases the rate and degree of cure.

Secret of the process is Sterling's still undisclosed method of preforming glass fibers for even distribution through the part. This method also allows the proper ratio of glass fibers to part thickness in sections made larger to provide added strength. In de-

Non-Habit-Forming

20
40
60
80
100
120
140
160
180
200

Pressure gage courtesy J. E. Lonergan Co., Philadelphia 6, Pa.

Beryllium Copper Tubing by Superior

This unusual term describes perfectly one of the most important properties of beryllium copper tubing. The Bourdon tube shown above is an excellent example. Once the beryllium copper tube is in the gage, it "remembers" its job and acquires no new habits. It yields constantly to pressure and as constantly returns to its original position without taking a new "set."

Beryllium copper tubing by Superior has this and many other important characteristics to a marked degree, such as hardenability, corrosion and fatigue resistance, thermal and electrical conductivity. It is easy to fabricate, it is nonmagnetic.

Beryllium copper tubing lends itself to a wide variety of applications. It can be severely worked to form convoluted flexible waveguides and bellows. Cold drawn to specifications, followed by proper hardening, it makes an excellent aircraft antenna, with the strength to withstand thousands of hours' vibrating in 100 mph winds. Used as a contact roll in a business machine collator, it is wear and corrosion-resistant, and a good electrical conductor. Or, as above, shaped for use as a Bourdon tube, it is tough, ductile, durable—and holds its original shape.

Superior produces tubing in over 63 analyses . . . in stainless, alloy and carbon steels, nickel and nickel alloys, beryllium copper, titanium and zirconium. Let Superior's tubemanship and experience help you solve your tubing problems. You'll like the service and the products—they *are* habit-forming. Send for your free copy of Data Memorandum No. 7 on beryllium copper tubing. Write Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company • 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

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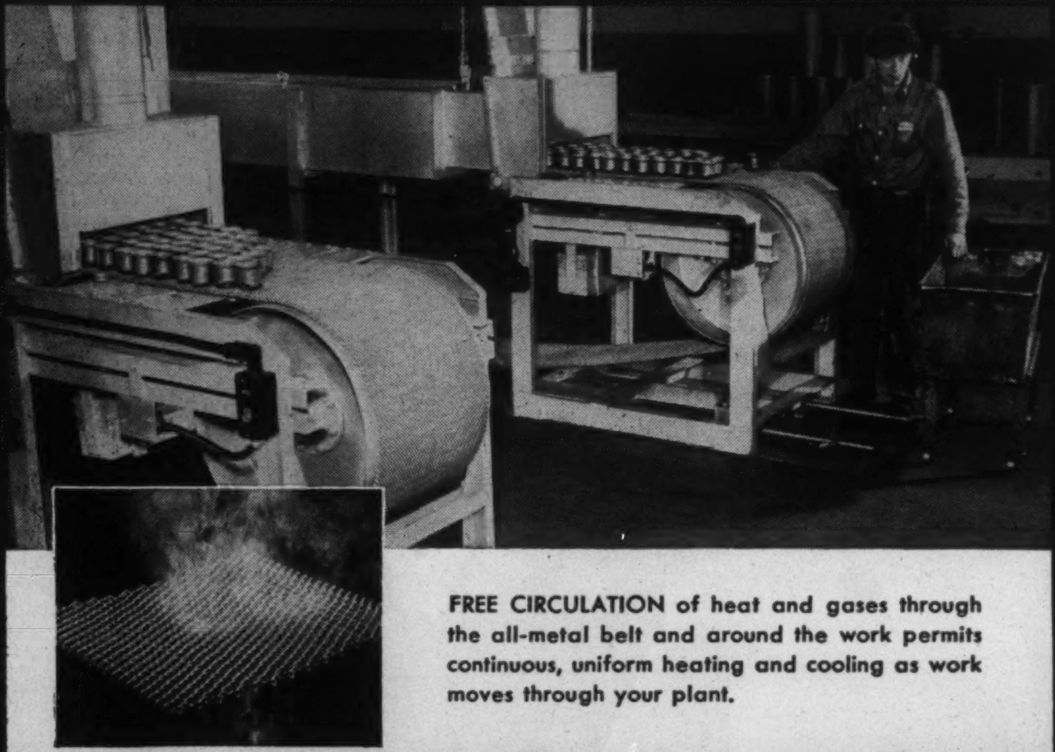
Cambridge

WOVEN WIRE CONVEYOR BELTS
take the "hot spots" out of
ANNEALING & BRAZING



FREE CIRCULATION of heat and gases through the all-metal belt and around the work permits continuous, uniform heating and cooling as work moves through your plant.

By combining controlled movement with free circulation of process atmospheres, Cambridge Woven Wire Conveyor Belts eliminate batch annealing and brazing. There is no formation of "hot spots" which produce local stresses. Continuous, belt-to-belt flow through subsequent quenching and washing operations as well as heating, cuts costs and provides fast, uniform production. Not only does the open mesh construction provide free circulation of gases . . . it also permits rapid drainage of process solutions. The all-metal belt is corrosion resistant and impervious to damage at temperatures up to 2100°F. Cambridge belts have no seams, lacers or fasteners to wear more rapidly than the body of the belt . . . no localized weakening.

Cambridge Woven Wire Belts for heat treating are made in any size, mesh or weave, and from any metal or alloy. Special retaining edges or cross-mounted flights are available to hold your product during inclined movement.

Call in your CAMBRIDGE FIELD ENGINEER to discuss how you can eliminate batch handling from your heat treating. Look under "BELTING, MECHANICAL" in your classified phone book. OR, write for your copy of Special Report, "6 Ways to Increase Heat Treating Production" and 130-PAGE REFERENCE MANUAL giving mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department A,
Cambridge 7,
Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

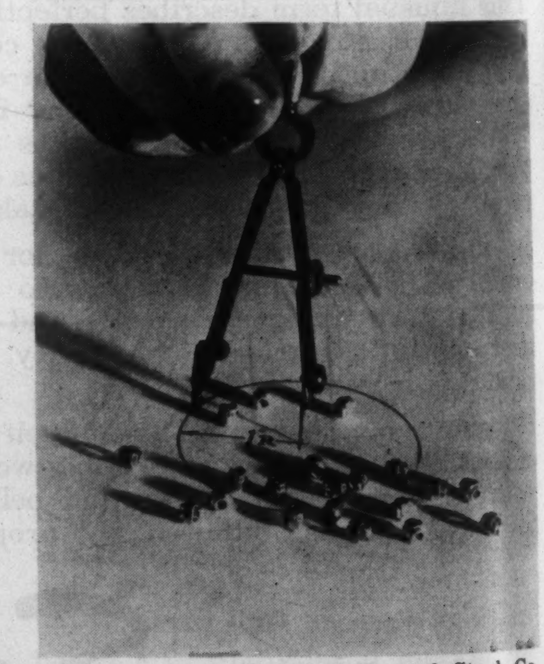
For more information, turn to Reader Service Card, Circle No. 364

veloping the preforming operation, Sterling eliminated the large blowers, ovens and numerous preform screens required by conventional preforming operations. The cost of glass in mat form and the waste in certain types of patterns has been offset by the reduction in scrap and high quality of the molded product.

NBS Metallurgists Report New Projects

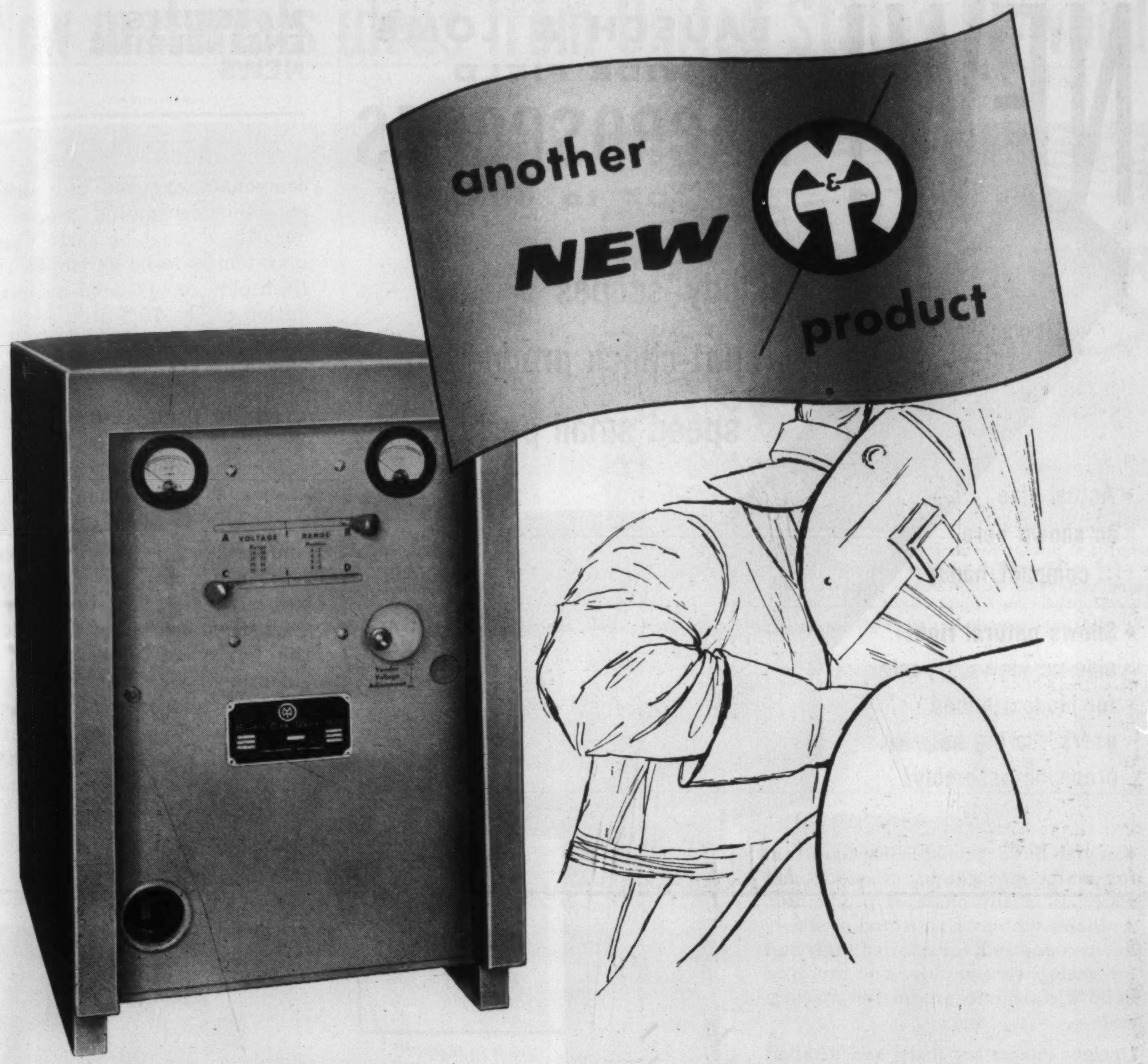
Announcement of two new brittle phases in the iron-chromium-nickel-molybdenum system and the initiation of work aimed at determining the fundamental principles underlying metal corrosion climaxed the annual metallurgical conference of the National Bureau of Standards. Headed by G. A. Ellinger and J. A. Bennett, the conference testified that the Bureau continues to uphold its world-wide reputation for scientific leadership.

Fe-Cr-Ni-Mo—Investigation of equilibrium diagrams of four



Standard Pressed Steel Co.

Miniature nuts Tiny clinch nuts, size 0-80 to 4-48, are available. These self-locking nuts are designed for blind mounting of small components on thin section panels.



M&T CONTROLLED-ARC POWER SUPPLY

for semi- and full-automatic welding

Here's another new Metal & Thermit product — the M & T constant voltage rectifier-type DC Welder as developed originally by the Glenn Co. When used in conjunction with a constant speed wire feed for semi- and full-automatic welding, it . . .

SIMPLIFIES OPERATION — for all practical purposes it maintains a constant arc length during entire welding cycle, thereby assuring a uniform deposit.

IMPROVES WELDING—uniform deposits are of high quality, regardless of conditions which normally affect arc length such as poor fit-up, tack welds, etc. — avoids undercutting on horizontal welds.

SPEEDS PRODUCTION — instantaneous starting and recovery get job underway faster with higher average rate of deposit — practically eliminates rejects.

CUTS POWER AND INSTALLATION COSTS—high efficiency and power factor permit lower wiring and operating power costs.

M & T Controlled-Arc Power Supply units are saving time and cutting costs on many semi- and full-automatic welding operations. Write for details on how they can help you.

WELDING SUPPLIES
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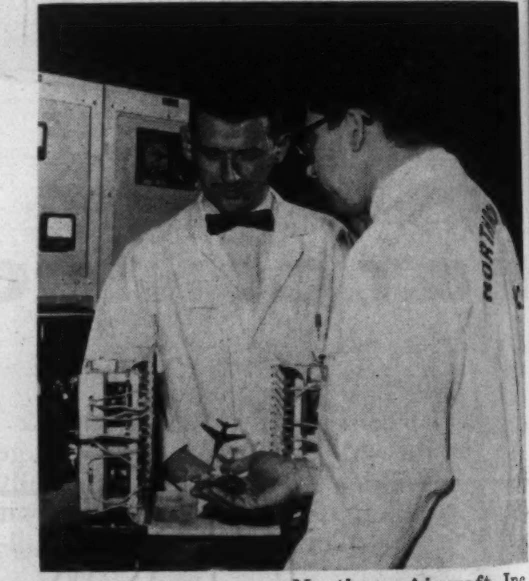
MATERIALS ENGINEERING NEWS

component systems is a difficult and time-consuming process but one which must be carried out if a system is to be developed. C. J. Bechtoldt reported on an investigation of the 70% iron section of the iron-chromium-nickel-and-molybdenum system at various temperatures. Two new brittle phases, eta and rho, were shown on newly-developed equilibrium diagrams. Identification of these phases brings the number of brittle phases in this system to five.

Measuring resistivity — Variation in certain physical properties, e.g., electrical resistivity, is a sensitive method of determining the purity of a metal and, incidentally, of determining the point beyond which there is no use in purifying a material as no additional property improvement is obtained. Since the Metallurgical Div. has been preparing high

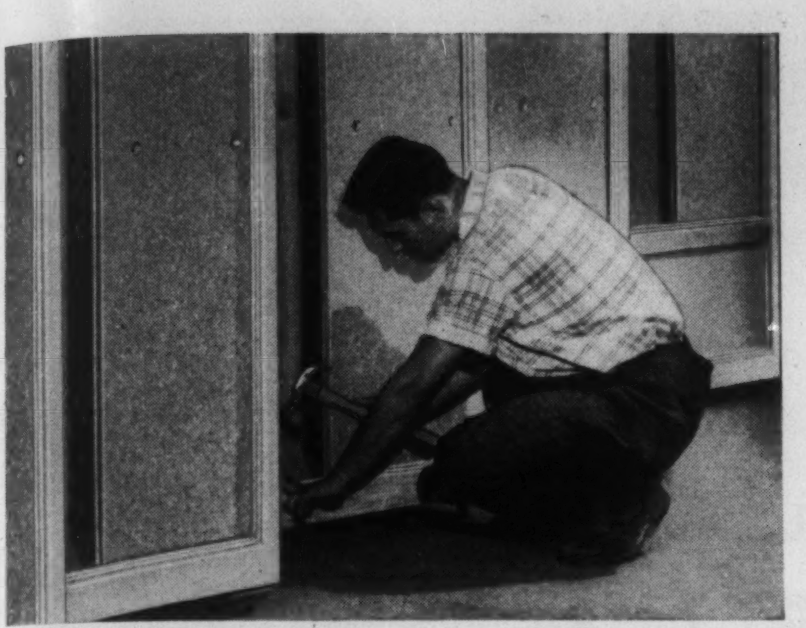
(continued on p 216)



Northrop Aircraft, Inc.

Thermal barrier The small cut-out airplane is flanked by infra-red quartz lamps capable of generating temperatures as high as 2000 F. The airplane facsimile is made of 0.051-in. aluminum alloy sheet, a standard aircraft skin material. Four seconds after lamps were lit, the facsimile plane began to melt. The aluminum alloy is known to lose 10% of its strength at 250 F, and 90% at the temperatures resulting from friction at 2000 mph.

New materials ideas from United States Plywood



Warp-free wood panel—Novoply—is a 3-ply laminate with faces of specially prepared wood flakes and a core of wood chips—all resin-impregnated and molded under heat and pressure to form a dense, hard, flat panel. Novoply is extremely rigid, dimensionally stable. In thicknesses from 3/8" to 1"; sizes up to 4' x 16'. Used as core stock for furniture, as sliding doors, and wardrobes. NOVOPLY®.

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New tough-faced plywood—Duraply—is exterior grade fir plywood with a smooth overlay face of phenolic resins and cellulose fibers. Twice as wear-resistant as ordinary plywood; smooth surface takes paint better, holds it longer; needs no primer coat. Used in boats, signs, outdoor furniture, building siding. In five thicknesses: 5/16" to 3/4"; all plywood sizes. DURAPLY®.

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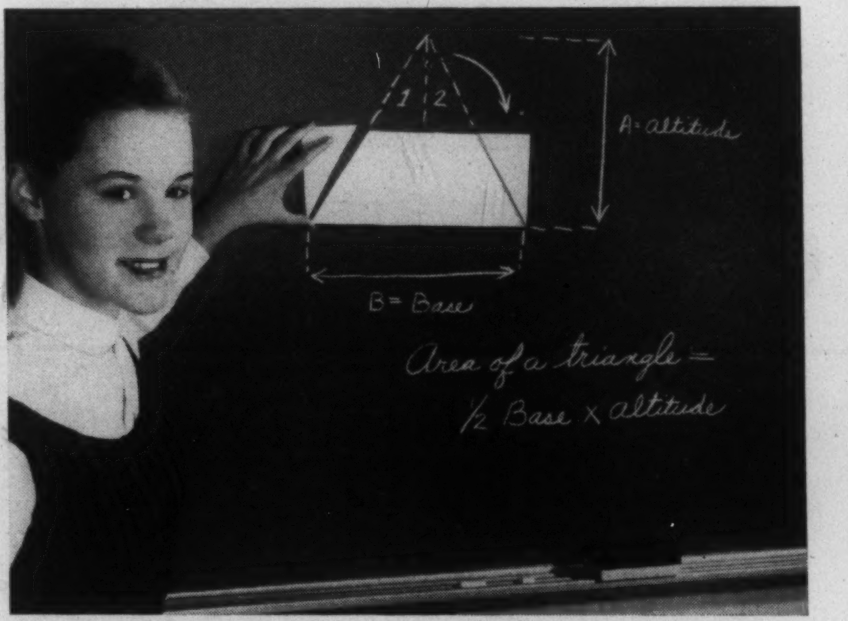
1
2
A = altitude
B = Base
Area of a triangle = 1/2 Base x altitude

New double-duty visual aid—Chalkboard—is writing surface and magnetic display board in one. Made of plywood with porcelain-on-steel face, and backed with steel. Magnets cling to surface to hold displays or demonstration material. Available in gray, green or blue; and in "projection white" for use as movie screen. Sizes to order, (max. width: 4'; max. length: 10'). CHALKBOARD .

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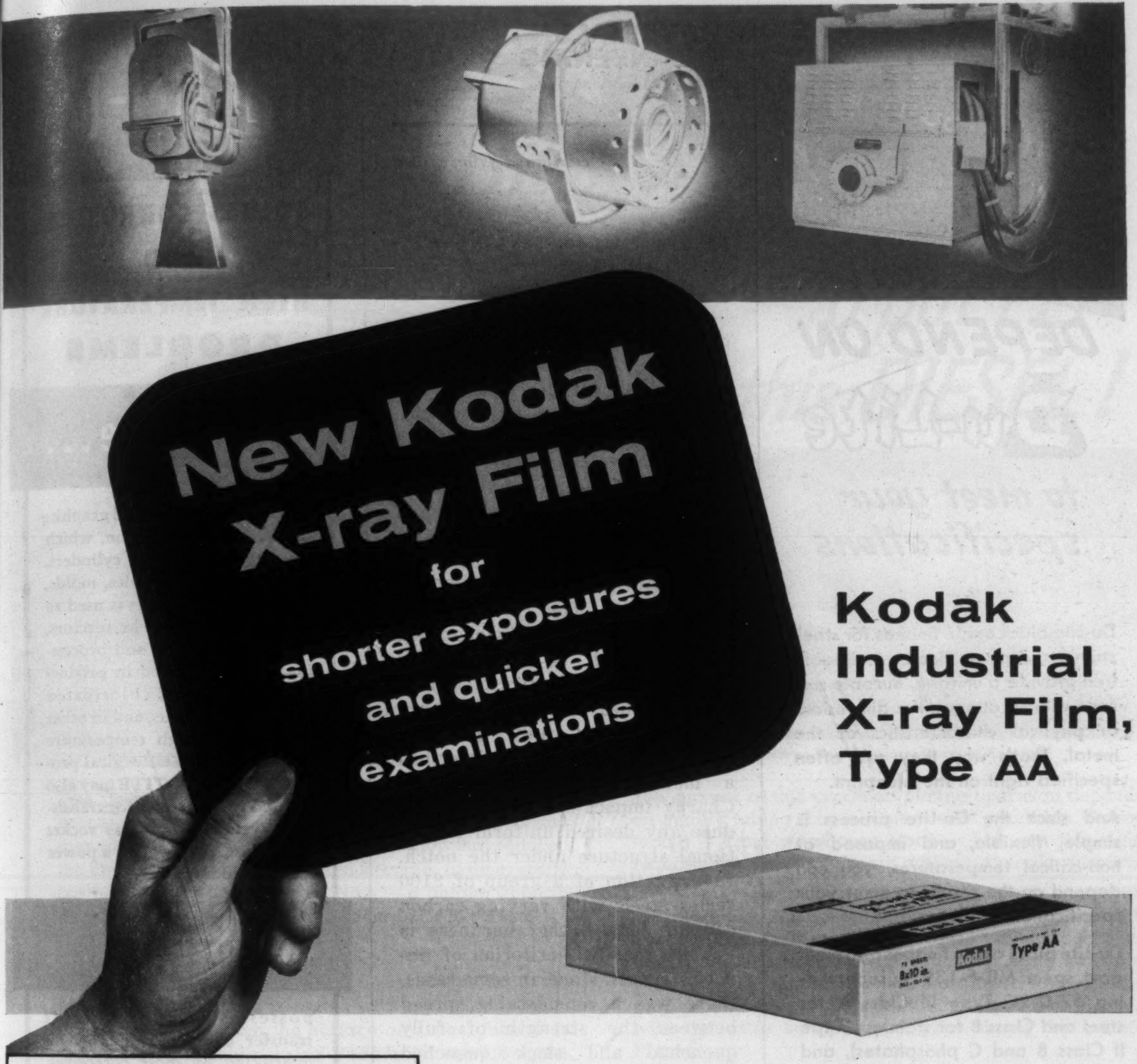

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MATERIALS ENGINEERING NEWS

continued from p 212

purity metals for property determination, it has become necessary to develop apparatus which can be used to detect and record small changes in properties with great precision. G. A. Moore discussed a new instrument developed to record changes in resistivity with increasing temperature with a high degree of precision and another which will record simultaneously changes in resistivity and expansion.

Varying structure—It has been estimated that not more than 20% of the steel used in the heat treated condition is fully quenched and tempered. In spite of this fact, in most investigations properties of heat treated steels are determined on fully quenched steels. M. R. Meyerson described a method of slack quenching Charpy impact specimens to produce any desired uniform transitional structure under the notch. Investigation of a group of 8100 series steels with varying carbon content showed that hardness is not necessarily a criterion of impact strength since, in some cases, there was a considerable spread between the strength of fully quenched and slack quenched steels at the same hardness level.

Watching fatigue—In attempts to determine the principles underlying the methods of failure by fatigue, many investigators have studied the role of crystal orientation in single crystals. By means of an ingenious arrangement of a torsional fatigue machine, a microscope and a motion picture camera, J. G. Weinberg is investigating the effect of crystal orientation on fatigue of polycrystalline metals. A movie of the progress of slip and the formation of cracks during a fatigue test on an aluminum alloy was shown to demonstrate the technique. The work shows that cracks originate on 111 planes and not at grain boundaries.

(continued on p 218)

Graph-i-tite

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is a carbon-impregnated graphite material of construction, which can be formed into cylinders, tubes, nozzles, crucibles, molds, and special shapes. It is used to contain fluid flow in reactors, for piping, nozzles and processing equipment used in production of chlorine, chlorinated metals, molten salts, and in other corrosive or high temperature chemical and metallurgical processes. GRAPH-I-TITE may also be used for crucibles for transistor crystal growth, as rocket nozzle inserts, as well as a power reactor moderator.

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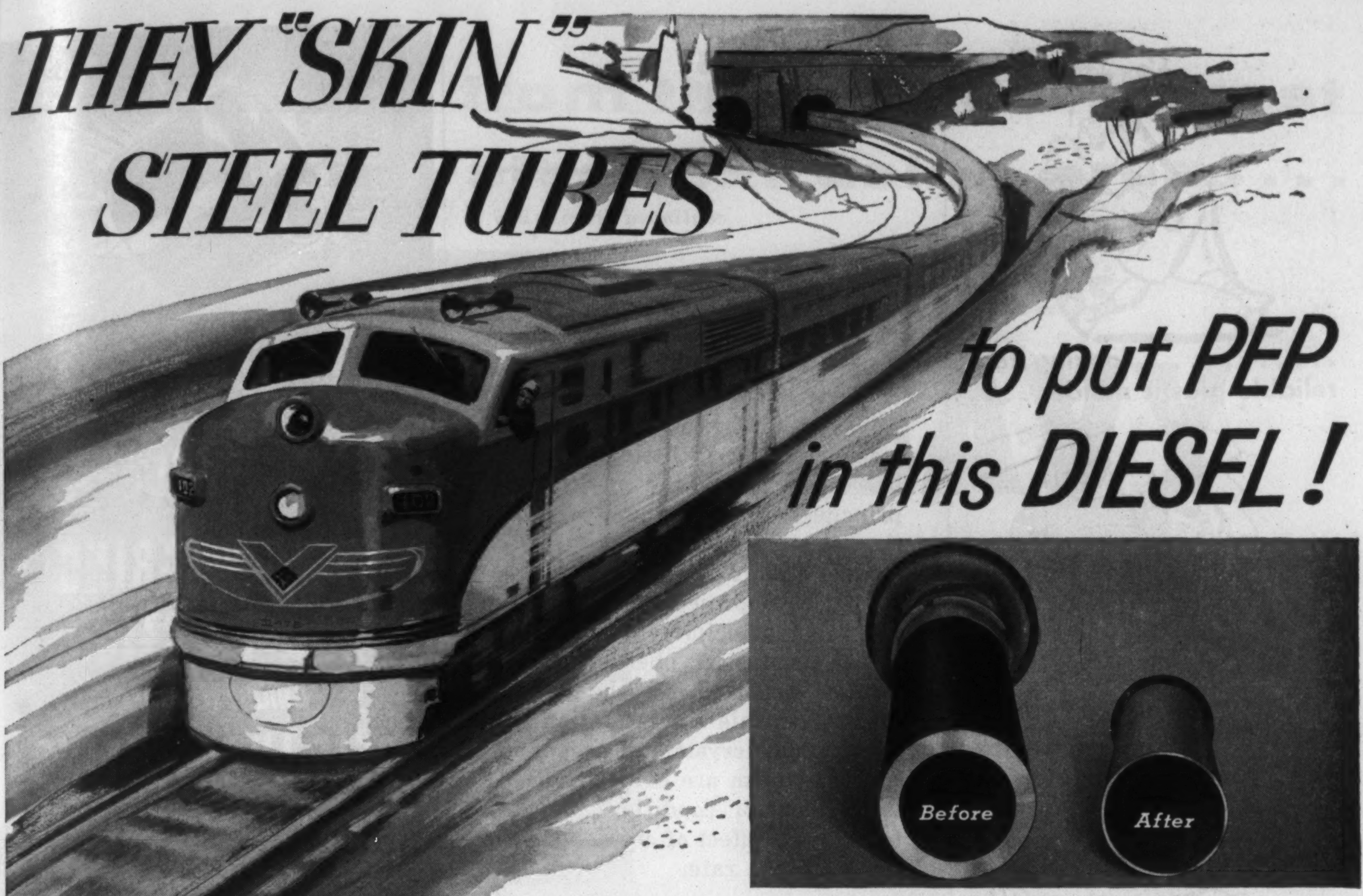
THEY "SKIN" STEEL TUBES to put PEP in this DIESEL!



Courtesy: Van der Horst Corp. of America

This powerful diesel loses its pep when cylinder liners become excessively worn. Formerly, this reoccurring ailment called for reboring — an operation that reduced the liner wall and its mechanical strength. In time, costly castings had to be scrapped. Now — a unique application of Frasse tubing helps put them back in service . . . indefinitely! Here's how.

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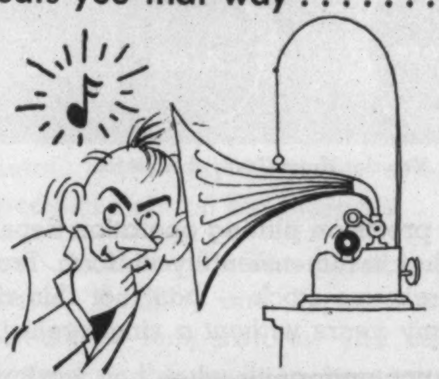

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continued from p 216

Corrosion principles—Although it is estimated that billions of dollars are lost through corrosion damage each year, and much time is spent in investigating corrosion phenomena, little attention has been given the underlying principles which would answer the question: Why does a metal corrode? The Division has started a long-term project to determine the basic principles which apply to all corrosion phenomena. J. Kruger reported on the initial stages of this investigation in which single crystals of copper in spherical form are being oxidized under control conditions to determine the effect of crystal orientation on the rate.

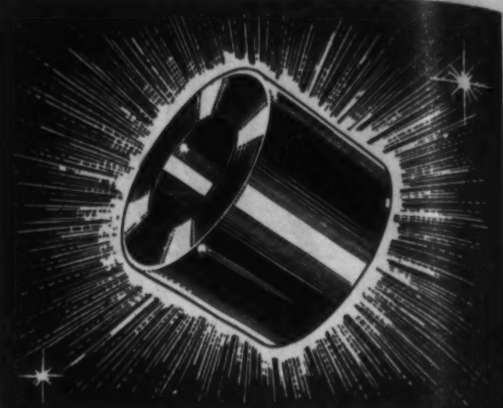
Vinyls Improved by New Additives

Three recent developments in the chemistry of polyvinyl chloride systems promise substantial improvements in end properties of vinyl sheet, film, molded parts and foams.

They are: 1) a primary plasticizer that greatly reduces the coefficient of friction of vinyl surfaces; 2) a light stabilizing system that more than triples outdoor durability of vinyls; and 3) a polymerizable dispersant for plastisols that exerts no plasticizing effect on the cured material. The first two are Monsanto Chemical Co. developments and the third is Union Carbide's.

Slick vinyl

Surface tack, or gripping, of PVC formulations is said to be reduced by more than 70% by the use of the new primary plasticizer developed by Monsanto's Organic Chemicals Div. With equivalent formulations, PVC plasticized with dioctyl phthalate, a conventional plasticizer, showed a coefficient of friction of 1.8 as compared with 0.5 for formulations containing the new plasti-



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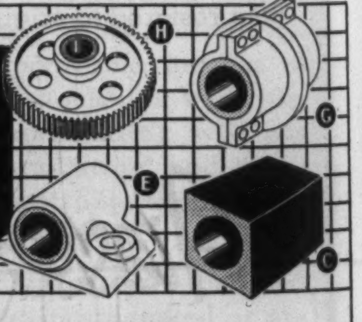

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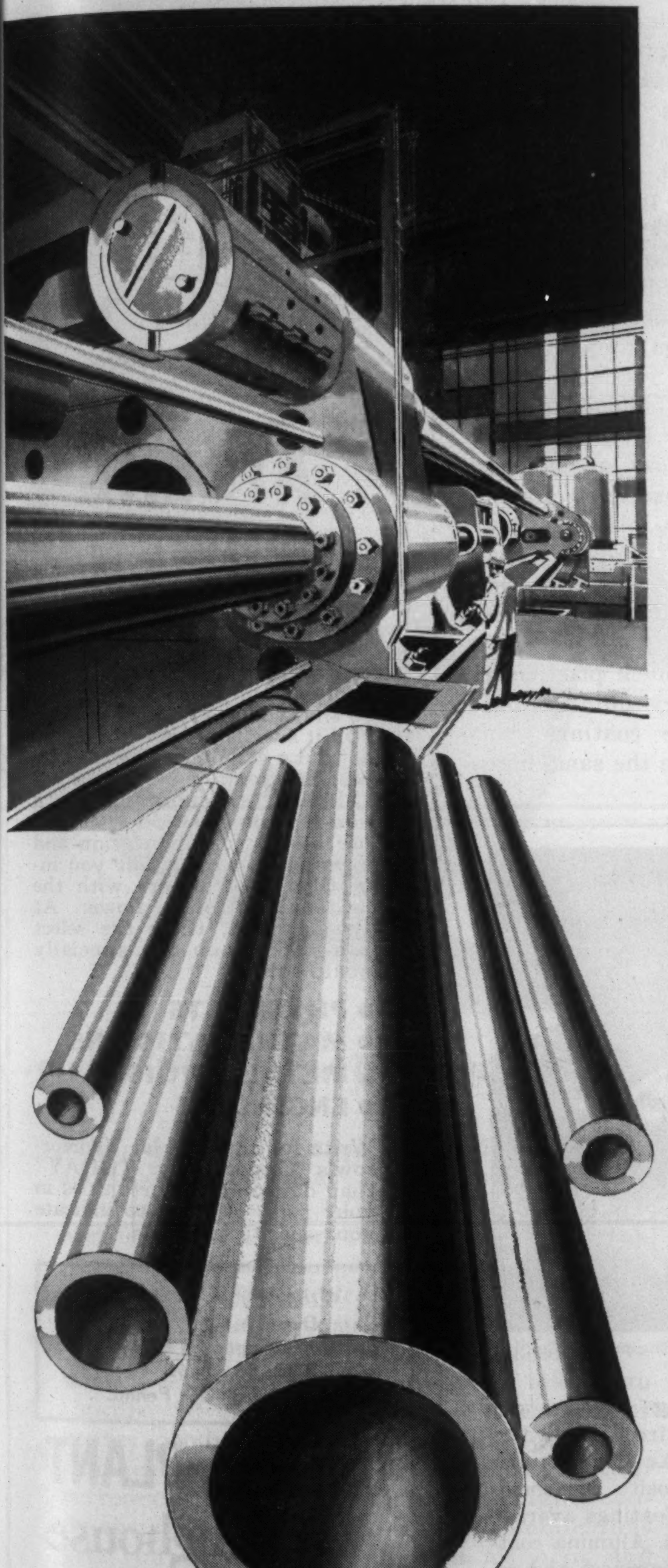

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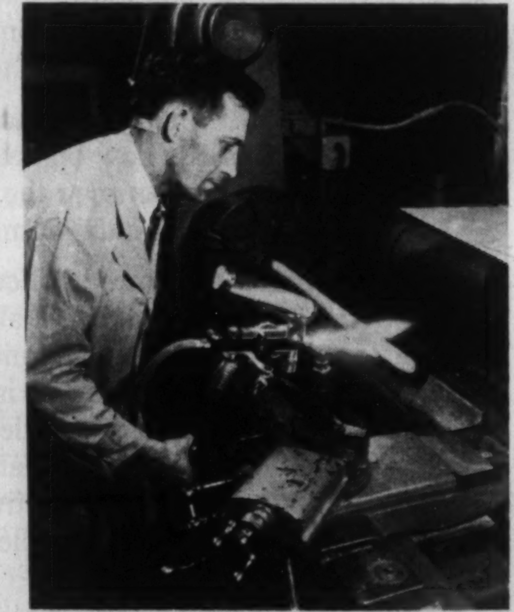
cizer, called Santicizer 213.

Reduction in tack is particularly advantageous in applications such as coatings for upholstery, where minimum drag is desirable. In packaging applications, a slick vinyl surface can greatly speed packing of vinyl parts in cellophane or polyethylene bags. According to Monsanto, the new plasticizer also aids cleaning of vinyl surfaces, since dirt retention is a minimum.

In addition to reducing tack, S-213 is said to enhance fusion characteristics of PVC formulations, improve gloss of molded, calendered and extruded items, and produce plastisols with low initial viscosities. Probably the most important of these is the last. For applications such as coatings for cloth, plastisols normally require so much plasticizer to obtain necessary fluidity that only very flexible coatings can be produced. Since the same high



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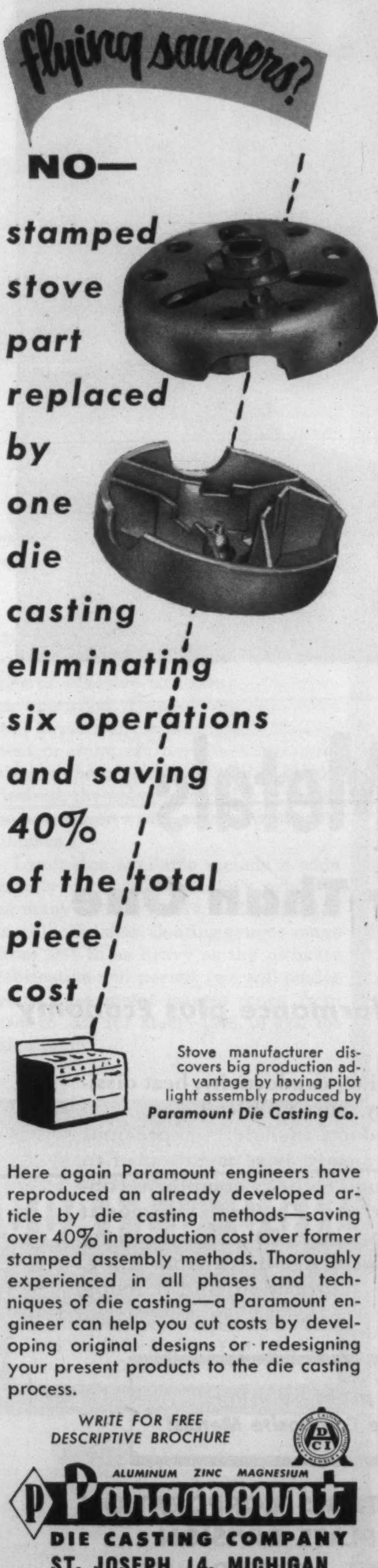
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degree of fluidity can be obtained with a much smaller quantity of S-213 the cured coating can be harder and more rigid. For example, a comparison of vinyl formulations with equivalent quantities of plasticizers gives a Shore A hardness of 85 with S-213, compared to 74 with DOP.

Known limitations of the new plasticizer are:

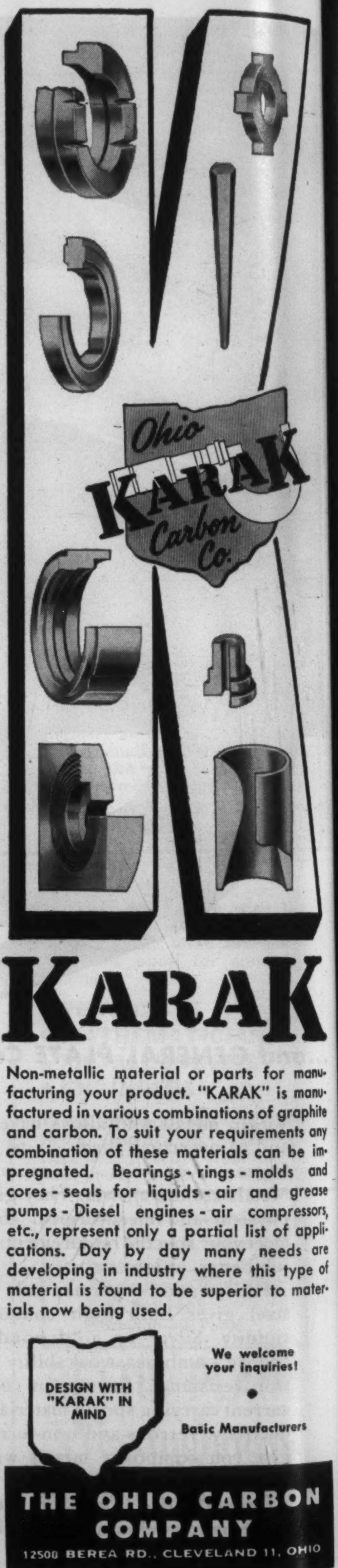
1. Heat and light stability of S-213—plasticized vinyls are not of the best quality. However, proper formulation can alleviate this problem.

2. The formulated materials build up viscosity rapidly and are relatively volatile. Monsanto has found that these characteristics can be controlled to a degree by proper formulation with other plasticizers.

There are several unknown per-

Synthane Corp.

Laminate bond strength Use of a standard, direct-reading force indicator makes it easier to test the strength of the bond between the metal foil and the plastic in a printed circuit laminate. After cutting a 1-in. test strip of copper foil away from the laminate, a force indicator is hooked to the strip and pulled until the copper test strip peels from the base material. Once the foil has begun to peel, the maximum indicator dial reading falls off slightly.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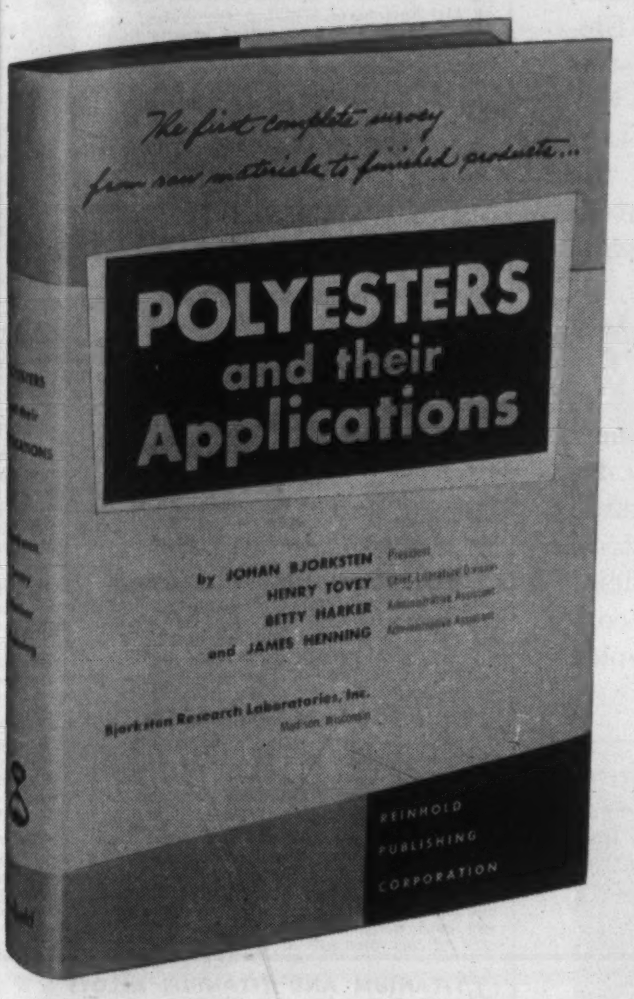
POLYESTERS

and their Applications


The first complete survey from raw materials to finished products...
POLYESTERS and their Applications
by JOHAN BJORKSTEN
HENRY TOVEY
BETTY HARKER
and JAMES HENNING
Bjorksten Research Laboratories, Inc.
REINHOLD PUBLISHING CORPORATION

1956, 576 pages, $10.00

by **JOHAN BJORKSTEN**
President

HENRY TOVEY
Chief, Literature Division

BETTY HARKER
Administrative Assistant

and **JAMES HENNING**
Administrative Assistant

all of Bjorksten Research Laboratories, Inc.
Madison, Wisconsin

This book is the first comprehensive survey of the entire polyester field from raw materials to fabricated product. The text and annotated bibliography of over 3300 references cover most phases of the production and use of polyesters. You will find here a storehouse of valuable information and a tremendous time-saver in seeking background information. Now you can quickly locate any patents or literature bearing on some particular phase of the polyester field. Included are not only the unsaturated polyesters used in molding, casting, coating, impregnating, and laminating, but also the saturated polyesters used in production of fibers, films, elastomers, and foamed plastics.

This fund of information has been painstakingly assembled for many years by the Bjorksten Research Laboratories. Periodic volumes will be published when merited, to make them a basic reference work covering the current status of the field and indicating the problems which must be overcome for further advancement and the directions of future trends.

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Introduction; General Concepts; Polyesters

2 UNSATURATED POLYESTERS
Raw Materials; Resin Manufacture; Catalysis and Inhibition; Fillers and Reinforcements; Shaping; Finishing; Commercial Resins; Tailor-Making Polyesters; Final Products

3 SATURATED POLYESTERS
Linear Fiber-Forming Polyesters; Di-Isocyanate-Modified Polyesters

4 TESTING
Introduction; Raw Materials; Resins and Plastics; Equipment for Testing Plastics; Catalysts; Glass Fillers; Design Data and Nondestructive Tests

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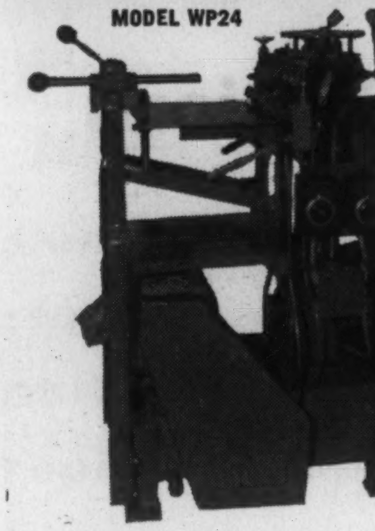

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MATERIALS ENGINEERING NEWS

formance characteristics of formulations containing S-213 which may prove to be limitations. Elevated temperature characteristics (125 F) are not known as yet, and these will be an important factor in the acceptance of the new plasticizer for transportation upholstery. Effects of the plasticizer on heat sealability or suitability for adhesive bonding are also unknown.

Light stable vinyl

Vinyl films containing a new light stabilizing system, also developed by Monsanto's Organic Chemicals Div., have withstood 5600 hr of accelerated artificial weathering before failure. In correlated outdoor tests, samples withstood 2 yr exposure. According to Monsanto, these results can be compared to approximately 1000 hr in the weatherometer and 6 mo outdoor exposure for film made of good standard vinyl formulations. Though initial testing has been limited to film, the system should work equally well with molding compounds and plastisols, thereby giving additional stability to vinyl molded parts, coatings and foams.

Monsanto Chemical Co.

***Vinyl films** containing a new light stabilizing system have withstood 5600 hr in weatherometer tests.*

The four-part system (which is added to the resin-plasticizer mix) is composed of barium-cadmium, an epoxidized soybean oil, an antioxidant and an organic ad-

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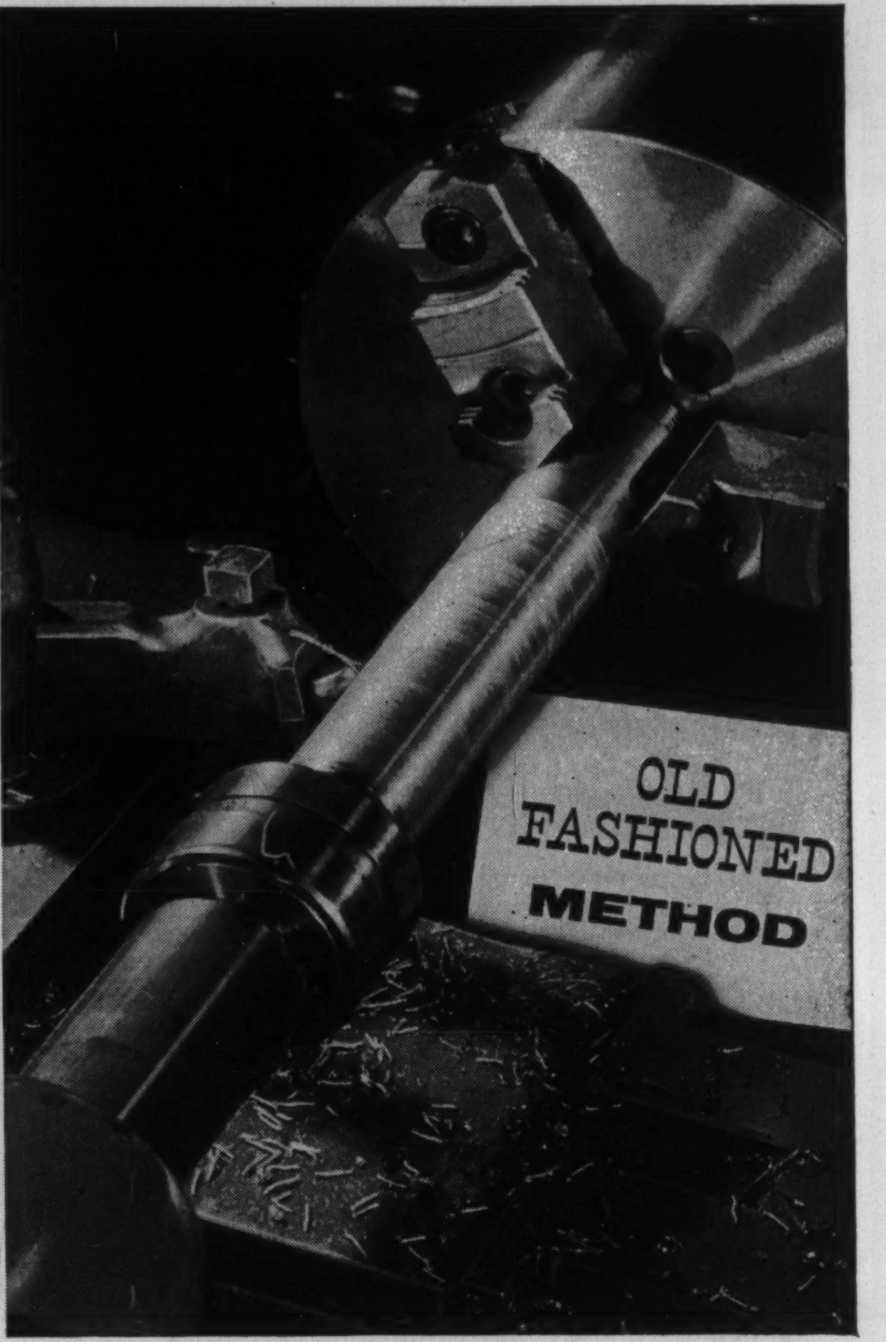

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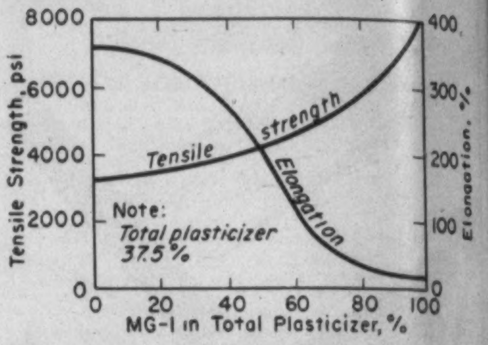
ditive. Although Monsanto produces none of the components of the system, the company has applied for a patent on the system and will make technical assistance available through its Technical Service Group.

Hard, stiff vinyl

The new dispersant for plastisols a low viscosity monomer designated MG-1 and developed by Carbide and Carbon Chemicals Co., polymerizes during fusion of the vinyl plastisol to form a resin which is compatible with plastisol resins and conventional plasticizers. Since polymerized MG-1 retains no plasticizing action, the cured vinyl part is hard and rigid. Varying proportions of plasticizers can be used with MG-1 to impart any desired degree of flexibility to the end part (see accompanying graph).



Curable dispersant, *monomer MG-1, increases strength and hardness of plastisol films, other vinyl plastisol products.*

The polymer with dispersant is recommended for production of such vinyl materials as flooring, doll parts, balls, wire coatings, tank linings, foams and sponges, gaskets and other applications where it is desirable to manufacture relatively hard vinyl plastics by plastisol techniques.

Fuel Elements Use Costly Metals

Designing reactor fuel elements demands a blend of ingenuity and foresight. For efficiency of operation, the designer must plan the placement of precise quantities of fuel material at carefully calculated points within the reactor. He must also take into consideration the erratic behavior of uranium in a fissionable environment (see p 9). Last but not least, his fuel, uranium, can cost as much as $11,000 per lb.

The strides made in fabricating these elements were dramatized by the opening of Babcock & Wilcox's Nuclear Facilities Plant in Lynchburg, Va.—the first fuel element fabrication plant built by private industry. Production has already begun on a year's supply of fuel elements for the U. S. Atomic Energy Commission's Materials Testing Reactor at Arco, Idaho. Delivery of the first 35 assemblies is scheduled for next month.

Biggest job for the plant will be making components of the first privately owned nuclear steam generator for Consolidated Edison Co. of New York. Production of fuel elements for this reactor will begin as soon as final design details have been completed.

All fuel elements produced by B&W at Lynchburg are clad with a protective coating, usually aluminum, zirconium or stainless steel. This cladding prevents corrosion, metal distortion due to irradiation, and the escape of

Nuclear Reactor Materials

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A comprehensive 20-page manual on the properties of structural, fuel and fertile materials used in nuclear power reactors. This article will also discuss the materials and design problems that must be faced now and what they are likely to be in the future.

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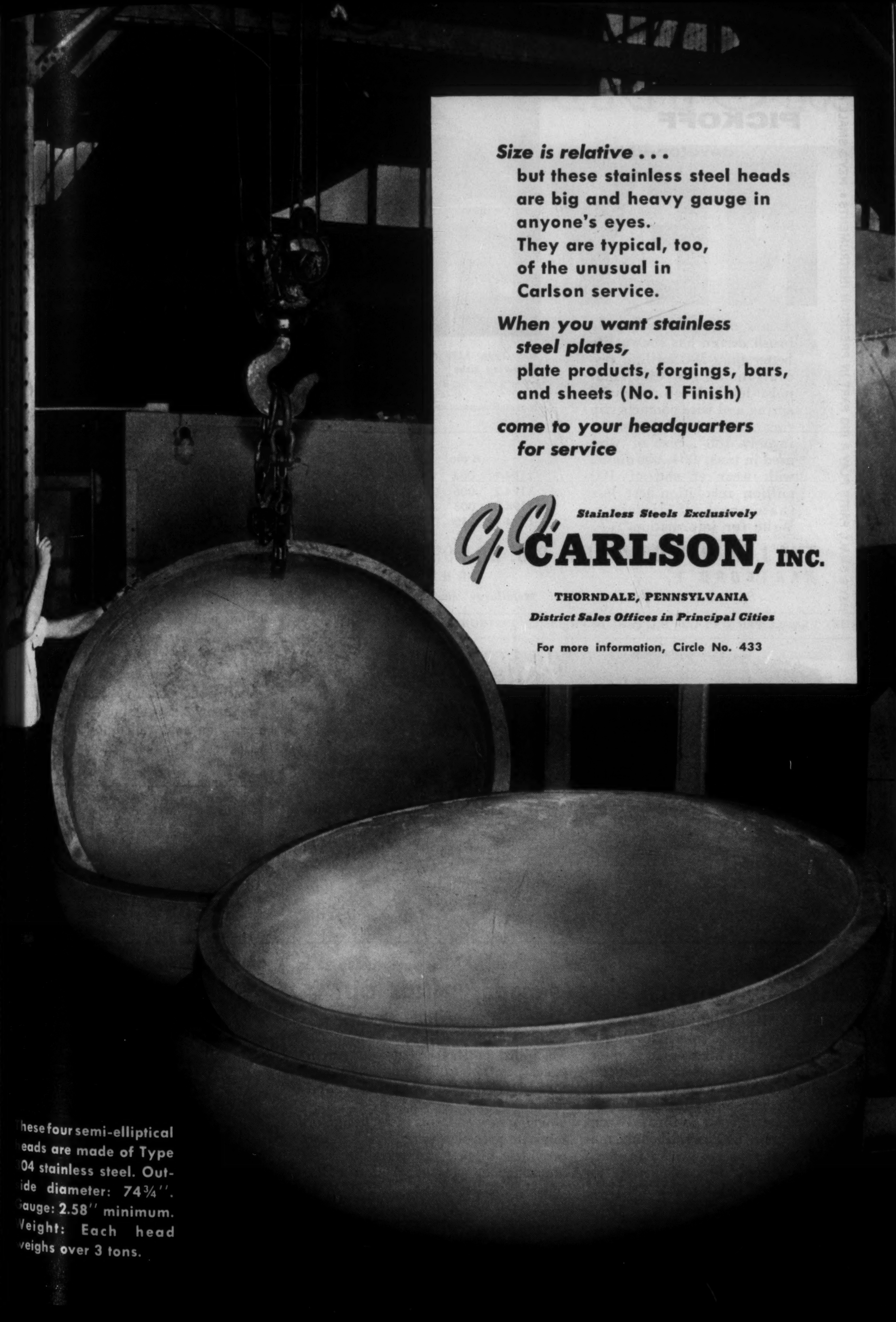

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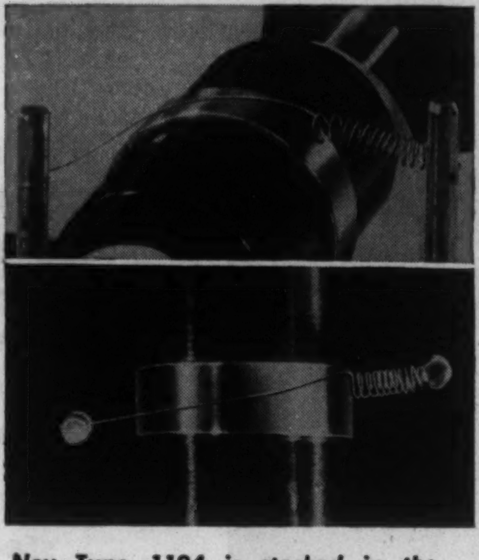

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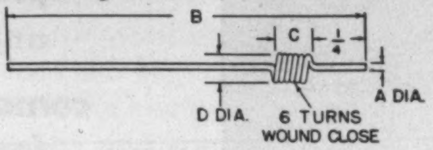

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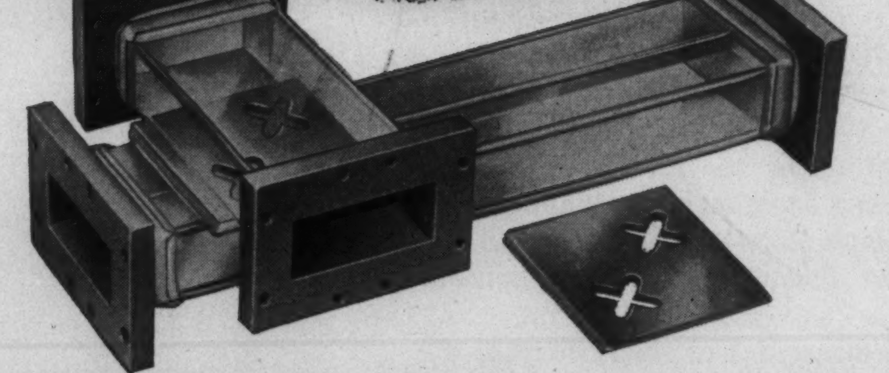

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MATERIALS ENGINEERING NEWS

radioactively hot fission gases.

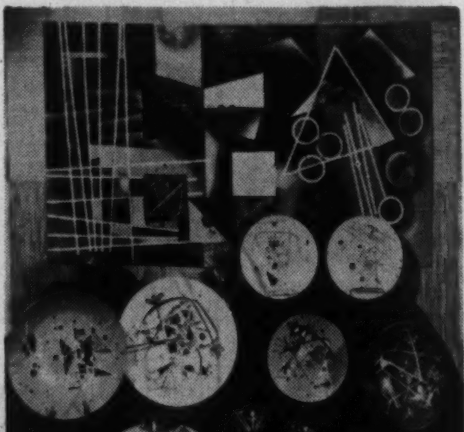
Fuel elements for the Consolidated Edison reactor will consist of alternate plates of uranium alloy and thorium clad in zirconium. During fission, the thorium will breed U 233, which will contribute to the chain reaction.

Production of these fuel elements will entail the following steps:

1. Zirconium and enriched uranium metal for fuel plates will be alloyed in a vacuum arc melting furnace. The 100-lb ingot will be remelted to improve homogeneity. At this stage the ingot will be worth approximately $40,000.

2. The ingot will be conditioned on a 10-in. lathe to remove imperfect material. Next it will be sheathed in steel, preheated to about 1450 F, and hot forged on an impacter to billet size. The billet will then be reheated and hot rolled to the approximate thickness of a fuel element core.

3. After removal of the steel sheath, the plate will be cleaned by vapor blasting and acid picking, then cold rolled to punching thickness. Core size pieces will be



Porcelainized aluminum, a relatively new engineering and architectural material, is now entering the housewares field. This use of porcelain enameled aluminum was pioneered by Edward Winter, Cleveland ceramic artist, in 1953. The above work was fired at 1000 F for 6 min. Colors are made by milling metallic oxides into a low temperature frit designed for aluminum.

MALLORY·SHARON reports on

TITANIUM

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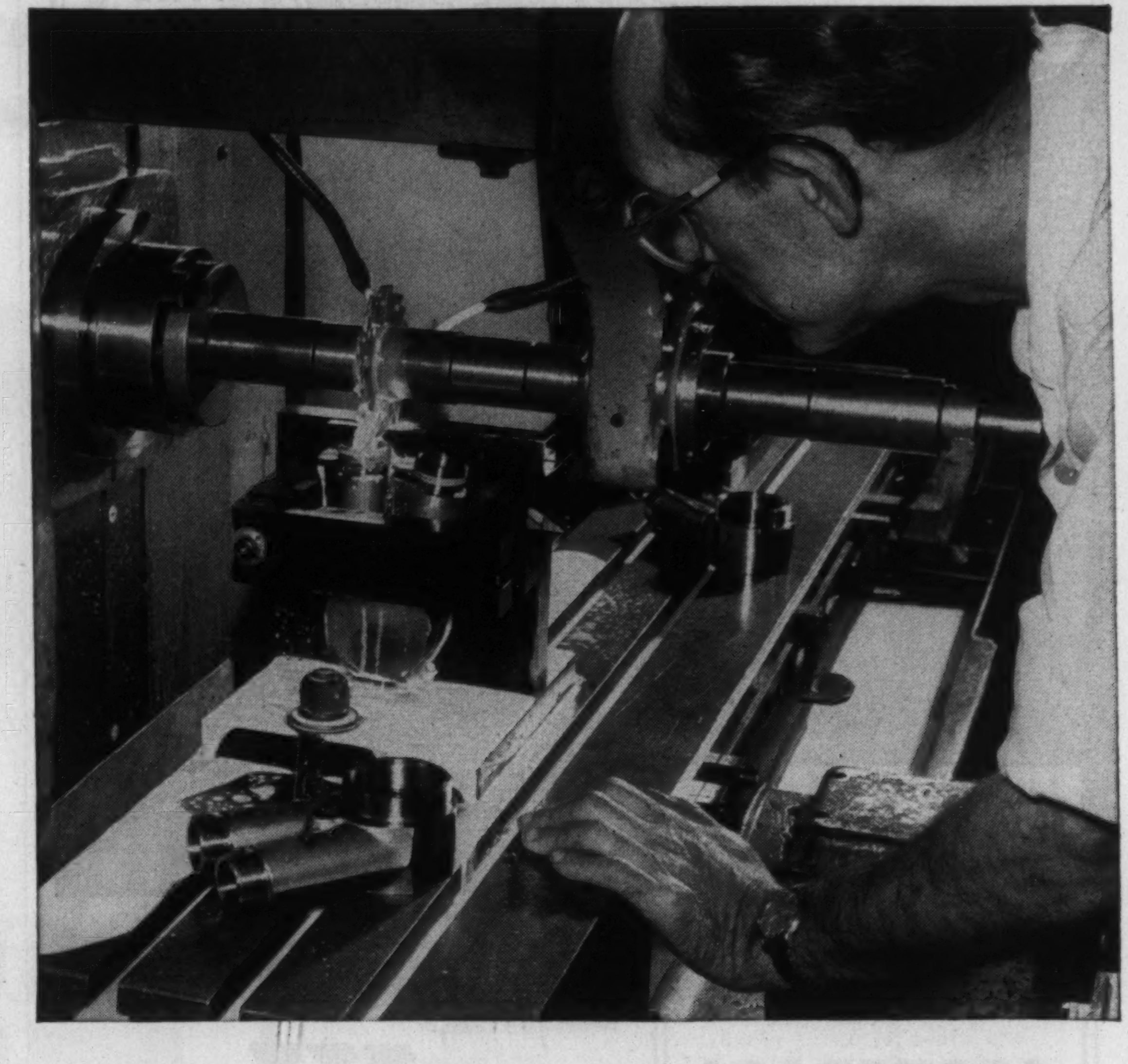
TITANIUM ALLOYS

can be machined in "soft" condition

...HEAT TREATED TO HIGH STRENGTHS



● New heat treatable titanium alloys can be machined and formed readily, yet offer exceptionally high heat treated strengths in final form. And titanium has the highest strength-to-weight ratio of any metal in the temperature range of 250°-800°F.

For example, Mallory-Sharon's MST-6Al-4V titanium alloy is available in the annealed condition with typical ultimate tensile strengths of 140,000 psi. Here machineability is comparable to that of stainless steel. After machining, parts can be heat treated to typical ultimate tensile strength of 185,000 psi.

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punched from the plate and assembled in a picture frame pattern with zirconium alloy cladding.

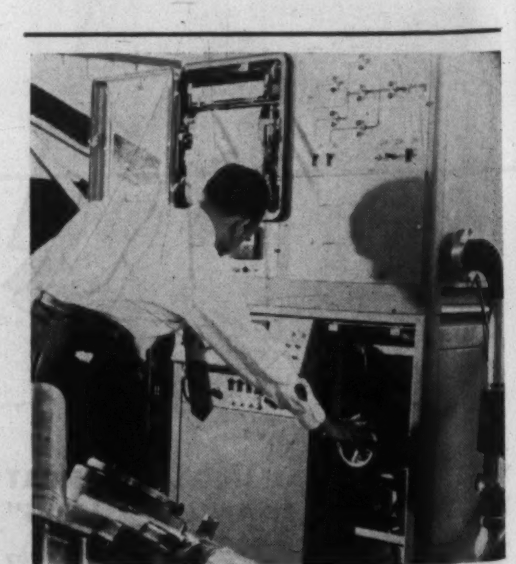
4. The assemblies will be sheathed in steel once more, heated in an electric furnace to about 1450 F and hot rolled to the approximate thickness of a finished fuel plate. After removal of the protective sheath, the element will be cleaned by vapor blasting and acid pickling, and cold rolled to final thickness.

5. Each plate will be examined in the laboratory fluoroscope to locate the fuel alloy, then machined to final width and length.

6. Thorium ingots for the fertile plates will be processed into strip form, clad in zirconium, and machined to final width and length.

7. Thirty thorium plates and 38 U235 plates will be bundled by positioning them in a jig and fusion welding. The welded assembly will be given a diffusion anneal in an electric furnace, an operation that stress relieves as well as anneals.

8. The assembly will be machined to final dimensions and fitted with end nozzles of stainless steel. After final inspection the fuel element will be ready for shipment.

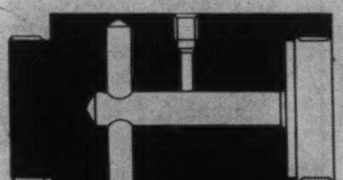


Carboloy Dept., General Electric Co.

Vacuum melting control is aided by a mass spectrometer which analyzes gases produced in the furnace while special alloys are being made.

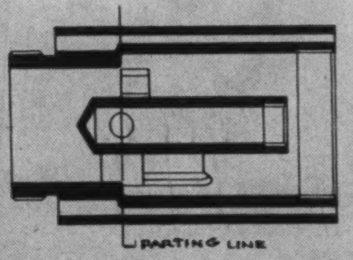
ROCKET FUSE IS REDESIGNED FROM WROUGHT ALUMINUM TO DIE CAST ZINC. RESULT:

50% cost reduction No increase in weight



WROUGHT ALUMINUM

Proper size bar stock must be procured, inventoried, cut to length. All holes had to be drilled and threaded. Aluminum bar stock required application of anodizing.



DIE CAST ZINC

Casting comes from die in proper shape and size. There is no inventory problem on raw material. Axial and cross holes can be cored to depth and diameter. Expansion plugs in place of screws saves tapping. For finishing, the zinc die castings need only inexpensive dichromate dip coating.

THE SPECIFIC GRAVITY of zinc being 2.4 times that of aluminum, this re-design of an airborne component presents an interesting turnabout. The switch from aluminum bar stock to die cast zinc in the manufacture of the rocket fuse owes its success to the nature of the die casting process. It permits placing the metal where it is needed, eliminating it where it is not. Thus, coring of the zinc die casting has reduced the volume of the fuse body, and the weight was held to 6155 grains—the same as that of the aluminum product it replaces. By producing the fuse as a cored zinc die casting rather than turning it on a screw machine from aluminum bar stock, the following operations were eliminated: 1) cut off, 2) drilling three holes, 3) threading two holes, and 4) anodizing. The zinc die casting requires the following operations subsequent to ejection from the die: 1) trimming flash, 2) cutting two threads, and 3) dichromate dip.

The change, made by Monarch Governor Co. of Willow Run, resulted in a 50% cost reduction. Production rate has been increased from 100 aluminum to 150 zinc die cast fuses in the same amount of time.

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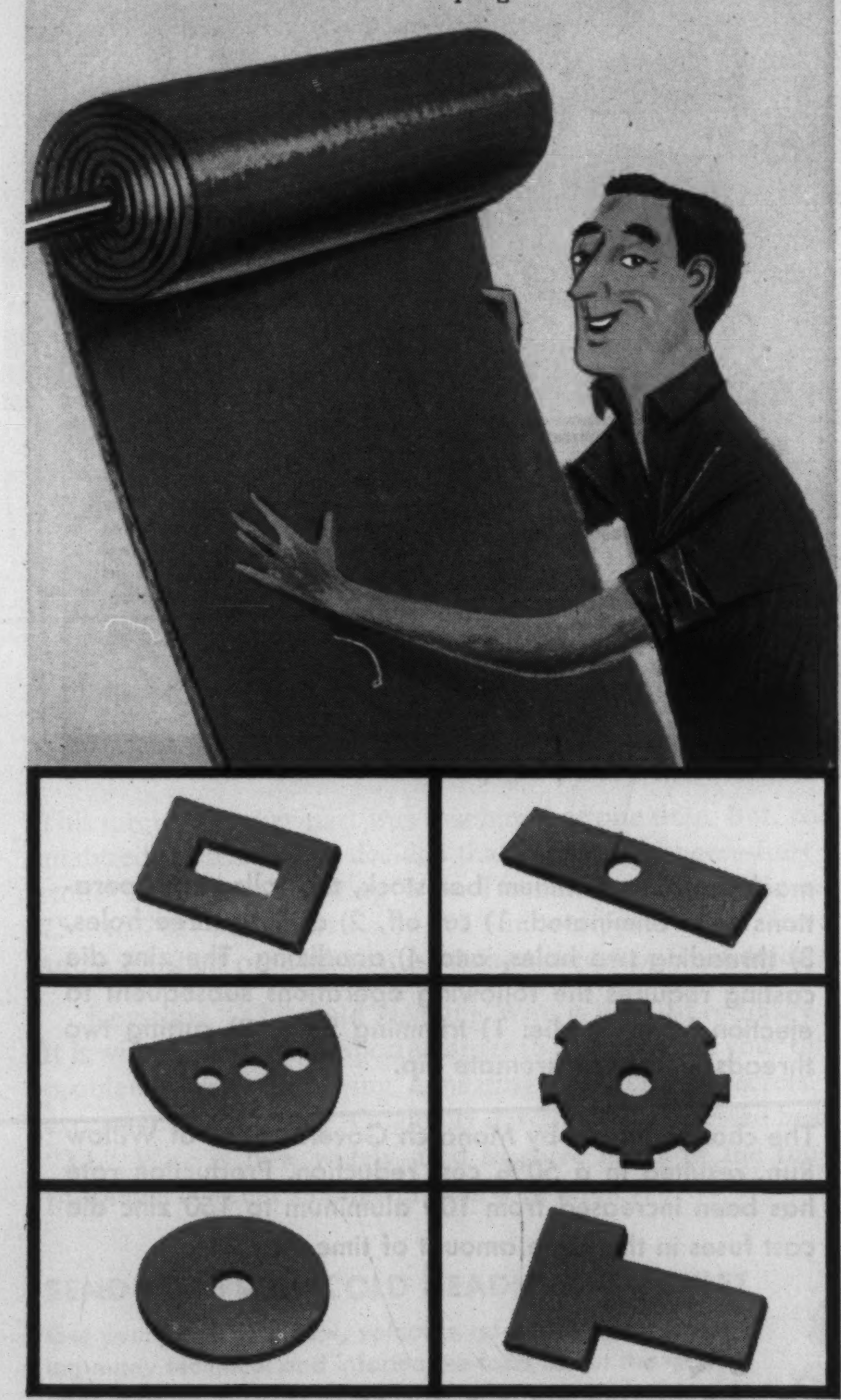

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LETTERS TO THE EDITOR

continued from p 14

these products has of course increased since the statistics were compiled. Any way the situation is viewed the tonnage of ceramic products produced annually is far in excess of plastics. I am sure that whoever wrote this statement was either misinformed or simply made a natural error.

Ralston Russell, Jr., Professor
Dept. of Ceramic Engineering
Ohio State University
Columbus, Ohio

To the Editor:

Thank you very much for bringing Mr. Russell's comments on our remarks concerning the U. S. Production total for "ceramics" to our attention. Although we are not familiar with this industry, we were surprised to see that Prof. Russell includes with ceramics such things as Portland cement and gypsum materials. We had not included data for these because we considered them separate items.

We had taken our original figures on ceramics from "Resources for Freedom" Volume IV, p 187, as set forth by the President's Materials Policy Commission. It was thought this report excluded such things as gypsum and cement and included products listed in standard Industrial Classifications 325 and 326. We are sorry if our category disagrees with Professor Russell who, as a professor of ceramic engineering, must undoubtedly know the industry more intimately than we do. In projecting the PMPC figures I believe we were remiss in underestimating the 1955 level. In this case, the old wheeze—"Our forecasting has been poor and we have the figures to prove it"—may apply.

James E. Sayre, Manager
Market Research
Barrett Div.
Allied Chemical & Dye Corp.
New York, N. Y.

Blasted wet

To the Editor:

In the January issue of MATERIALS & METHODS, Manual No. 123 on "Wrought Aluminum Alloys," you discussed chromium plating over aluminum after wet blasting. I would appreciate more information on the process and data on the maximum and minimum thickness of coating obtainable. Could you suggest a manufacturing source in Michigan or surrounding area?

Paul Brincheck, Test Engineer
Research Dept.
Holley Carburetor Co.
Van Dyke, Mich.

Cro-Plate Co., Inc., 747 Windsor St., Hartford, Conn., holds the patent on this process. They would be able to direct you to any licensees in the Michigan area. Additional information on this process can be obtained by referring to M&M, Oct '50, p 56.